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The Morphology of the Head of Homoptera

By

J. W. Evans, M.A., F.R.E.S.

(Read 8th November, 1937)

NATIONAL MUSEUM OF VICTORIA

Although a great deal of attention, on the part of several workers, has been devoted to a study of the head structure of Hemiptera, the interpretation of which presents one of the most controversial questions in external insect anatomy, uncertainty still exists as to the correct homologies of the various sclerites. Hence in taxonomic papers the same part of the head may be named differently according to the views held by the respective authors.

The present work has been made possible by the recent discovery of abundant material of *Hemiodoecus fidelis* Evans, a representative of the Peloridiidae, which is undoubtedly the most archaic hemipterous family still in existence.

PELORIDIIDAE

The Peloridiidae, which comprise the whole of the series Coleorrhyncha, have been fully discussed by Myers and China (1929), China (1932), and Helmsing and China (1937), and, as pointed out by Helmsing and China, 'may well be descended in an almost direct line from proto-hemipterous ancestors'.

The first interpretation of the head-structure of an insect belonging to this family was given by Myers and China, and was based on an adult specimen of *Hemiodoecus leai* China. The sutures that limit the sclerites of the head, though distinct with the nymphal instars, are unrecognisable in the adult head, hence these authors made certain errors in their interpretation. The present author, in an earlier paper (Evans, 1937, *b*), also incorrectly interpreted part of the head of a peloridiid, since he based his interpretation on a specimen mounted on a slide, without previous dissection.

Figure 1 represents the head of a pre-imaginal nymph of *Hemiodoecus fidelis* Evans. Between the eyes lies the large vertex, which, owing to the opisthognathous nature of the head, is entirely ventral in position, and which is divided medially by the coronal suture. This branches anteriorly as the epicranial suture, which lies along the posterior margin of the frons. On either side of the frons is the frontal suture, and separating the frons from the clypeus, the epistomal suture. From the point of junction of the epistomal suture with the frontal suture, on each side of the head, arise the sub-genal sutures. The genae bear the antennae, and are separated from the vertex on each side by an ill-defined suture that does not continue as far as the eyes.

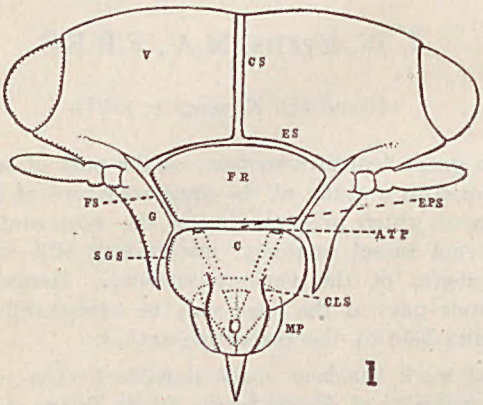


FIG. 1.—Head of *Hemiodoecus fidelis* in facial aspect.
v., vertex; *cs.*, coronal suture; *es.*, epicranial suture; *fr.*, frons; *fs.*, frontal suture; *g.*, gena; *eps.*, epistomal suture; *atp.*, anterior tentorial pit; *sgs.*, sub-genal suture; *c.*, clypeus; *cls.*, clypeal suture; *mp.*, maxillary plate.

It will be noticed that, apart from the epistomal and sub-genal sutures, three sutures have been named separately, instead of two as is usual. Myers (1928), under the term 'epicranial suture', includes doth the coronal and epicranial sutures, whilst Snodgrass (1935) retains the present coronal suture, but includes both the epicranial and frontal sutures under the term 'frontal suture'.

The clypeus is divided into two parts (Fig. 2), an anterior part from the ventral wall of which arises the labrum, known usually as the labrum-epipharynx, and a posterior part which bears anteromedially the impressions of the dilator muscles of the sucking-pump, and extends laterally on either side as swollen lobes (the 'frontal lobes' of Myers and China). These lobes are recurved anterolaterally, and each has an external ridge close to its anterior margin. The sides of the anterior portion of the clypeus extend posteriorly

into the body of the post-clypeus, and the sutures that divide the clypeal lobes from the median part of the clypeus, are the clypeal sutures. The clypeal lobes continue under the ante-clypeus medially, and are joined to the ventral wall of the sucking-pump, whilst the mandibles are attached to a ridge on the anterior internal margin of each lobe.

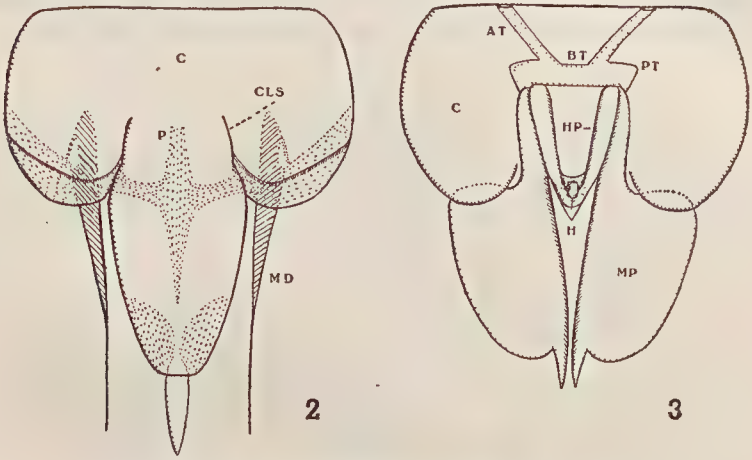


FIG. 2.—Clypeus of *H. fidelis*.

p., posterior extension of floor of sucking-pump; *md.*, mandible.

FIG. 3.—Maxillary plates and post-clypeus of *H. fidelis*.

at., anterior arm of tentorium; *bt.*, body of tentorium; *pt.*, posterior arm of tentorium; *hp.*, apodeme of hypopharynx; *h.*, hypopharynx;. Other lettering as Figure 1.

Figure 3 is a diagram of the same part of the head shown in Figure 2, after the removal of the ante-clypeus and floor of the sucking-pump. Arising from pits on the epistomal suture are the anterior arms of the tentorium; these join the posterior arms which form a transverse bar through the back of the head; the median part of the bar is the body of the tentorium. Whilst in orthopteroid insects the tentorial structure is X-shaped, according to Snodgrass the π form, rather than the X form, is the more primitive type. Attached to the tentorial bar anteriorly are the apophyses of the hypopharynx and processes of the maxillary plates; the maxillary stylets are attached to the latter processes. The maxillary plates, which are largely hidden by the clypeus, and which may be removed as distinct sclerites, are not in any way connected with the genae.

FULGOROIDEA

The head-structure of members of this group have been studied by Muir (1926) and Snodgrass. The interpretation that follows is based on that already given for the head of *Hemiodoecus*.

Figure 4 represents the head of *Achilus flammeus* Kby., which differs from that of *Hemiodoccus* in that the clypeal suture entirely separates the median clypeus from the lateral lobes, the mandibular stylets are attached to the posterior internal corners of the clypeal lobes, and the maxillary plates are fused with the genae. Although in *Achilus flammeus* the clypeus is divided by a superficial transverse suture into an ante- and post-clypeus, with many fulgoroids (e.g., *Platybrachys* spp.), it still consists of a single sclerite.

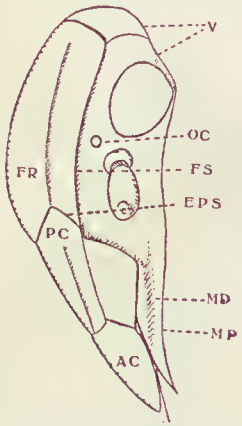


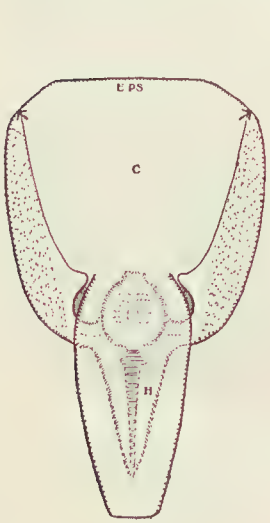
FIG. 4.—Head of *Achilus flammeus*.
p.c., post-clypeus; *a.c.*, ante-clypeus; *oc.*, ocellus. Other lettering as in previous figures.

Figure 5 represents the clypeus of *Eurinopsyche doddi* Dist. (Fulgoridae). The ante-clypeus projects from the post-clypeus, and bears the dorsal wall of the sucking-pump on its ventral surface. The ventral wall of the sucking-pump, anterior to the point at which it narrows posteriorly, is apparently joined to the rounded anterior internal margins of the sides of the post-clypeus. The median part of the post-clypeus supports the dilator muscles of the sucking-pump, and is separated from the lateral parts by superficial sutures; and the sides of the clypeus are recurved marginally, and to them are attached the mandibles at the points indicated by arrows.

The epistomal suture separates the clypeus from the frons, and the vertex forms the crown and sides of the head. Just as the presence of a median ocellus on a sclerite is sufficient evidence that the sclerite is of frontal original, so may the position of the lateral ocelli be used in determining the vertex.

Figure 6 represents the anterior part of the head of *E. doddi* viewed from behind, and is reproduced to indicate how the maxillary plates are separated from the genae by sub-genal sutures, and how

the maxillary apodemes are fused with the posterior arms the tentorium. The apophyses of the hypopharynx lies below the tentorial bar (above in the figure). In all members of the Fulgoroidea that have been examined, the proximal ends of the anterior arms of the tentorium have been found unattached, but from their position it is probably that they originate on the epistomal suture. Dorsal tentorial arms occur in some genera, and arise from the anterior arms close to their approximation with the body of the tentorium.



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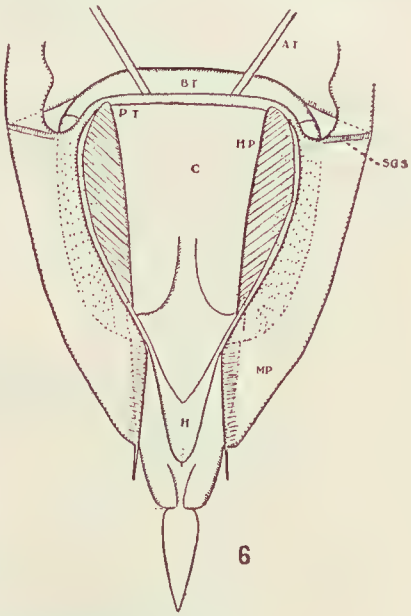

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FIG. 5.—Clypeus of *Eurinopsyche doddi* in facial aspect.
FIG. 6.—Anterior part ♂ head of *E. doddi* from behind. Lettering as in previous figures.

CICADIDAE

Although the morphology of the cicadan head has been investigated more thoroughly than that of any other hemipterous type, uncertainty still exists as to the homologies of the various parts.

Figure 7 is a diagram of a head of a cicada in facial aspect. Posteriorly between the eyes is the vertex, on which occur the paired ocelli. The larger part of the vertex lies on the crown of the head (Fig. 9), and is divided medially into two halves by the coronal suture which branches anteriorly into the epicranial suture; the arms of this suture enclose the frons which bears the median ocellus. Anterior to the frons, and separated from it by the epistomal suture, is the post-clypeus. The epistomal suture extends laterally on either

side of the post-clypeus, to a position slightly in front of the antennae, where it joins the clypeal suture. The clypeal suture then extends to a position just in front of the suture separating the ante- and post-clypeus, where it meets the genal suture, whilst its apodeme, which narrows posteriorly, close to each antenna, widens anteriorly, and the apodemes from each side of the head meet under the ventral surface of the sucking-pump and may be fused with it. The lorae, or mandibular plates, are joined to the genae posteriorly, to the apodemes of the clypeal suture laterally, and to the circular membranous plate already described, medially; they thus have no apparent connection

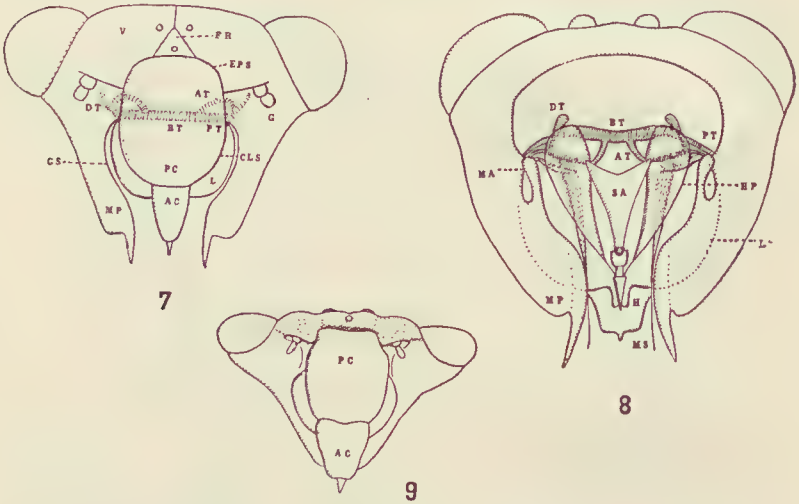


FIG. 7.—Diagram of the head of a cicada in facial aspect.
gs., genal suture; *l.*, lorum.

FIG. 8.—Head of *Tettigarcta tomentosa* from behind.
sa., apodeme of salivary syringe; *ms.*, maxillary stylet; *ma.*, maxillary apodeme. Other lettering as in previous figures.

FIG. 9.—Head of *Macrotristria angularis*.

with the clypeus. On either side of the lorae are the maxillary plates, which are suspended from the genae, but not separated from them by a sub-genal suture. The head of the cicades differs from those of fulgoroids, in that the maxillary plates are widely visible in facial aspect; in the reduction in size of the frons; in the absence of a sub-genal suture; in the posterior extension of the clypeal suture; in the arching of the epistomal suture; and in the separation of the lorae from the clypeus.

Figure 8 is a diagrammatic representation of the head of *Tettigarcta tomentosa* White; the maxillary plates have been pulled apart to disclose the hypopharynx, and to separate the apodemes of the

latter from those of the maxillary plates, to which the maxillary stylets are attached. Medially behind the hypopharynx is the salivary syringe and its apodeme. The apodemes of the hypopharynx, though closely apposed to the posterior arms of the tentorium, are not fused with them. The anterior arms of the tentorium arise from the epistomal suture, where it meets the clypeal suture, at the posterior apices of the lorae, and the dorsal arms branch from the anterior arms close to their points of origin.

CERCOPIDAE

The head structure of the Cercopidae, which has been studied previously by Doering (1922), is very similar to that of the Cicadidae, differing principally in the absence of a median ocellus. The greater part of the face of the head is occupied by the post-clypeus, which is separated from the vertex posteriorly by a small rectangular frons. The frons, which may be distinct, or amalgamated with the post-clypeus, always lies on the crown of the head, whilst the post-clypeus may be entirely ventral or extend on to the dorsal surface.

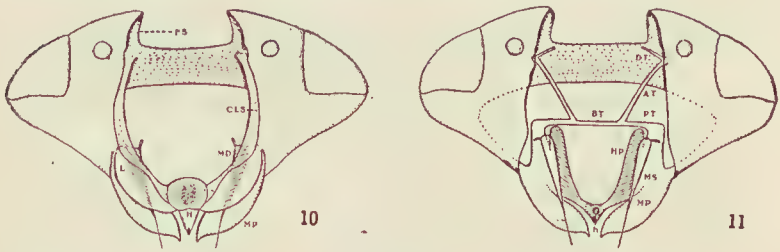


FIG. 10.—Head of *Hindola compacta* in facial aspect, the frons and clypeus having been removed.

FIG. 11.—Same as Figure 10, the lorae also having been removed. Lettering as in previous figures.

Figure 10 represents the head of *Hindola compacta* Walk. (Machaerotinae), from which the ante-clypeus, post-clypeus, frons, and antennae have been removed. Attention is directed to the clypeal sutures and their apodemes, which terminate close to the antennae, and to the attachment of the lorae to these apodemes and to the genae posteriorly. Figure 12 represents the lorae, clypeal apodemes, and mandibular stylets of the above species after removal from the head capsule, and shows the point of attachment of the stylets to the lorae. To the backward prolongation of each stylet are attached the retractor muscles, which arise on the dorsal wall of the head, whilst the protractor muscles are inserted on the bi-segmented connecting strut, and extend to the inner anterior margin of each lorum. Figure 11 represents the head after the removal of the lorae and their attachments. It will be noticed that the posterior

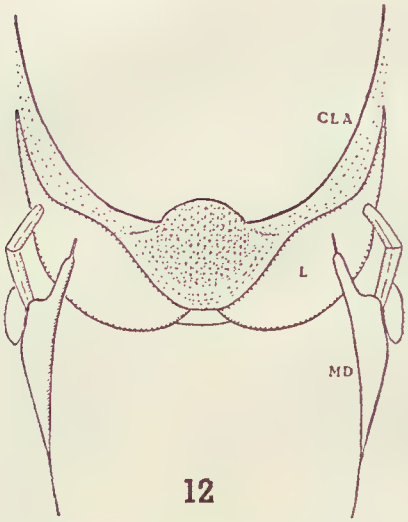


FIG. 12.—Lorae, mandibles, and clypeal apodeme of *H. compacta*. *cla.*, clypeal apodeme.

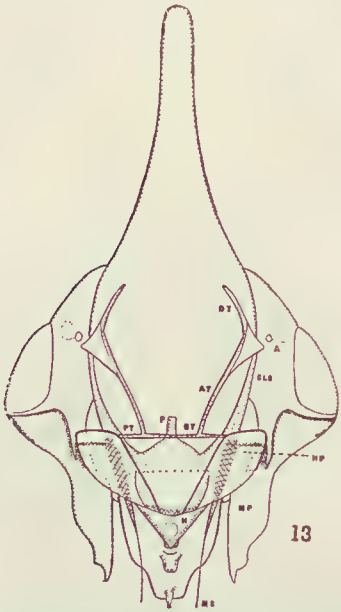


FIG. 13.—Head of *Philagra parva* from behind, the dorsal surface of the post-clypeus frons and vertex having been removed.
a., antenna. Other lettering as in previous figures.

arms of the tentorium are fused with the maxillary apodemes, and that the latter are not fused with the hypopharyngeal apophyses distally, although joined to them anteriorly. Each maxillary stylet is articulated with a maxillary apodeme by means of a short transverse lever. The anterior arms of the tentorium, as in the Cicadidae, arise from the apices of the epistomal suture, where they join the clypeal suture.

In *Philagra parva* Don. (Fig. 13) the apodemes of the maxillary plates are reduced in size, whilst the posterior arms of the tentorium are fused with the hypopharynegeal apophyses. The narrow posterior prolongation of the ventral surface of the sucking-pump, shown in the figures, lies above the anterior junction of the clypeal apodemes, and connects with the pharynx.

JASSOIDEA

The heads of jassoid insects differ from those of the groups already considered, in that with the majority there is no trace of the frons as a distinct sclerite, and the anterior arms of the tentorium, which serve to support the antennal muscles, are not attached to the body of the tentorium. Also, in the majority of jassoid families, although the clypeal suture is distinct, there is little development of a clypeal apodeme.

Figure 14 represents the head of *Eurymeloides pulchra* Sign., which has been chosen for description, since but for a narrow crown all the head lies in one plane. Between the eyes is the vertex, and medio-anteriorly lies the fronto-clypeus. As pointed out elsewhere (Evans, 1936, *a*), in the nymphs of some species of *Tartessus* (Euscelidae) a distinct rectangular plate occurs immediately behind the sclerite bearing the impressions of the dilator muscles of the sucking-pump, which in adult insects is fused with the post-clypeus. The rectangular sclerite referred to is the frons, hence the large median sclerite of most jassoid insects may be assumed to consist of all the frons and part of the clypeus. The rest of the head in facial aspect needs no further description.

When viewed from behind (Figs. 15, 16), just above the antennal scrobes are short struts, which are attached at their proximal ends to the antennal scrobes close to the point of junction of the clypeal and frontal sutures, and presumably at the apices of the lost epistomal suture. These are the anterior arms of the tentorium, the pits of which have been seen in the heads of nymphs of certain genera *(Aethalion* and *Rubria)*. Joining the distal ends of the hypopharyngeal apodemes is a narrow bar; this bar consists of the apposed posterior arms of the tentorium. The apodemes of the maxillary plates are fused with those of the hypopharynx, and the maxillary stylets are attached to the former. With the Eurymelidae the ventral wall of the sucking-pump and its support are intimately joined to the hypopharynx, and form its dorsal wall.

As has been pointed out by previous workers, the homologies of the various parts of the labium are uncertain. It is possible that the segments labelled in Figure 15, mentum, prementum, and paraglossa, are derived from the corresponding parts of the mandibulate labium, but this not certain. A pair of small structures lying between the paraglossae may represent the glossae.

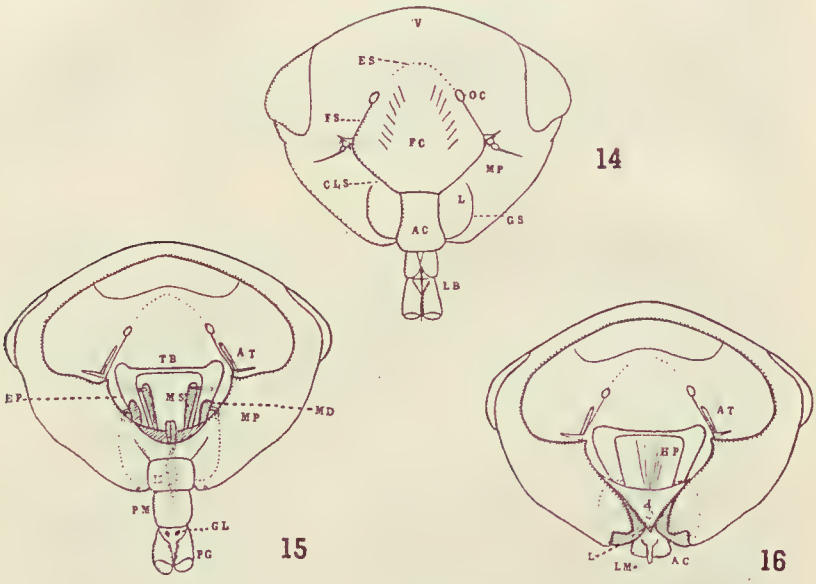


FIG. 14.—Head of *Eurymeloides pulchra* in facial aspect.
lb., labium; *fc.*, fronto-clypeus.

FIG. 15.—Head of *E. pulchra* from behind.
tb., tentorial bar; *m.*, mentum; *pm.*, prementum; *gl.*, glossa; *pg.*, paraglossa.

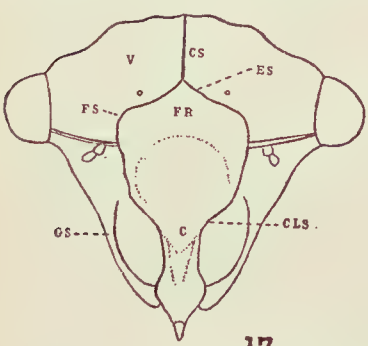
FIG. 16.—Same as Figure 15 after the removal of the labium and the stylets.
lm., labrum. Other lettering as in previous figures.

Figure 17 represents the head of *Aethalion reticulatum* L., after treatment in caustic potash, and is reproduced to show the presence of the coronal suture, which is absent in the majority of adult jassoids. There is no suture present between the ante-clypeus and post-clypeus, but an indistinct trace of a suture occurs, as shown, on the fronto-clypeus. This may indicate the boundary between the frons and post-clypeus; hence the suture branching anteriorly from the coronal suture is the epicranial suture, the suture that extends from the termination of the epicranial suture to the antennae, the frontal suture, which in turn connects with the clypeal suture. If this interpretation is correct, the rounded suture faintly discernible

on the fronto-clypeus must be the epistomal suture, traces of which remain in a number of jassoids, as, for instance, *Smicrocotis obscura* Kirk.

Figure 18 represents the head of *Deltocephalus* sp., and is reproduced to show the presence of dorsal tentorial arms, which have not been noticed in any jassoid genera, other than with those that belong to the family Euscelidae.

It is possible that the diversity in the shape of the head that occurs among jassoid insects, may be due, in part, to the reduction in size of the anterior arms of the tentorium, since those muscles which were formerly attached to these arms will have taken upon new positions and set up new stresses. Whilst in the majority of jassoid



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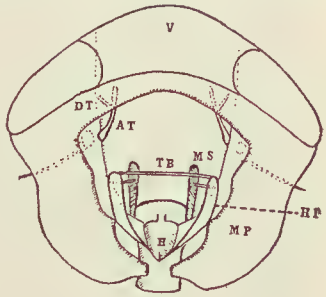

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FIG. 17.—Head of *Aethalion reticulatum* in facial aspect.
FIG. 18.—Head of *Deltocephalus* sp. from behind. Lettering as in previous figures.

families the frons is incorporated in the same sclerite as the post-clypeus, and the suture (when present) that divides the fronto-clypeus from the vertex is the epicranial suture, it is believed that in the Signoretidae, Pythamidae, and Eucanthidae, the frons is a distinct sclerite. In these families a small-circular area occurs on the crown of the head, bounded by the edge of the head anteriorly and by a raised carina posteriorly. The area referred to is the frons, the carina marks the epicranial suture, and the edge of the head separating the post-clypeus from the frons, the epistomal suture. The vertex consists of a narrow margin to the back of the head, which extends anteriorly on each side of the frons, and the ocelli lie on these extensions.

MEMBRACIDAE

The membracid head is similar to that of the Jassoidea in the possession of a tentorial bar which has no connection with the anterior arms of the tentorium. It differs from them (apart from

the Aethalionidae) in the retention of the coronal suture in the adult head. Muir was of the opinion that the one characteristic possessed by the head of Membracidae, which was different from those of the rest of the Cicadoidea, was that the post-clypeus (his frons) overlaps and often entirely hides the ante-clypeus. However, this character also occurs in the jassoid genus *Austrolopa* Evans (Ulopidae). In some of the membracid heads examined, the clypeal suture was not well-defined, so that the lorae appeared to be separated from the sides of the head rather by folds than by sutures.

STERNORRHYNCHA

The present study is principally concerned with the Colerrhyncha and Auchenorrhyncha, and only a few Sternorrhynchous types have been examined, belonging to the Aphididae and Psyllidae.

The principal feature in the head structure of these families is the separation of the head into two parts by a deep cleft, formed by the epistomal and sub-genal sutures. Posterior to this cleft the only distinct suture, which may be present or absent, is the coronal suture. With the Aphididae the frons is not defined as a distinct sclerite, and with the Psyllidae, only the median ocellus remains to mark its position.

The anterior portion of the head of certain aphides (e.g., *Pineus pini* Koch.) bears a striking resemblance to that of *Hemiodoecus*, in the development of the clypeal lobes, to the sides of which the mandibular stylets are attached, and in the small maxillary plates which are not fused with the genae. With the Psyllidae, clypeal lobes are not evident, and the maxillary plates are greatly reduced. Whilst with certain aphides the anterior tentorial pits occur close together towards the centre of the epistomal suture, with others, and with all the psyllids examined, they lie at the apices of the suture, which is somewhat arched medially. In the latter family the anterior arms of the tentorium are strong struts, that serve to brace the sides of the anterior part of the head.

Discussion.

Apart from the work of Snodgrass, the most recent and detailed study of the structure of the homopterous head is that of Myers, who, although particularly concerned with the cicadan head, referred to other groups and reviewed the earlier literature. In a paper published two years before that of Myers, Muir revised the views he had presented in earlier papers written in collaboration with Kershaw, and in a short note published in 1929 he altered his previous interpretation in so far as the tentorium was concerned.

VERTEX.—Little discussion has centred round the identity of the vertex, excepting with the Fulgoroidea, but confusion has been caused by the misuse of the term. The vertex is that part of the head that lies directly above the frons, whether the latter is distinct or incorporated in the fronto-clypeus. As pointed out by Baker (1923), the term is not synonymous with 'crown', since the vertex may lie in part on the face and in part on the crown, and the fronto-clypeus, post-clypeus, or frons, may extend on to the crown.

FRONS.—The frons is present as a distinct sclerite in the Peloridiidae, Fulgoroidea, and Cicadidae. With the Cercopidae it may consist of a small rectangular plate on the crown of the head, or appear to be absent, in which event it must comprise the hindmost portion of the post-clypeus. Muir considered the frons of fulgoroids to be the vertex, as does Snodgrass, although the latter believes a small triangular area bearing the median ocellus, such as occurs with some species, is of frontal origin.

With most jassoids and all membracids, the frons is incorporated in the same sclerite as the post-clypeus.

CLYPEUS AND LORAE.—According to Comstock (1920), although the clypeus almost always appears as a single sclerite, it really consists of a row of three sclerites, one in the median line and one on each side. The lateral sclerites are the ante-coxal pieces of the mandibles.

The clypeal lobes of *Hemiodoecus* may well be homologous with the ante-coxal pieces of certain mandibulate insects (e.g., the larvae of *Corydalus*), because of their position, and because of the attachment of the mandibular stylets to the surface of the anterior recurved margins. It is not difficult to trace the relationship between the clypeal lobes of *Hemiodoecus*, and of members of the Fulgoroidea, with the lorae of other groups. The transition will have been associated with the stresses set up by the dilator muscles of the sucking-pump, and their gradual backward migration on the clypeal plate, resulting in the enlargement of the median clypeus and the arching of the epistomal suture. This will have been accompanied by the simultaneous backward extension of the clypeal sutures and their apodemes.

The floor of the sucking-pump consists of a more or less circular membranous plate that is joined to the clypeal apodemes and the lorae. As pointed out by Muir, this plate is of double thickness, the two layers usually being fused together, but with insects shortly after ecdysis their separation is possible, when it is found that the lorae are attached to the ventral layer, and thus the median continuation does not actually constitute the lower surface of the mouth cavity, but its support.

Whilst with all types studied, with the exception of *Hemiodoecus*, the mandibles are articulated with the posterior corners of the lorae, their protractor muscles still retain their position on the inner anterior

margins. That the lorae are not part of the mandibles, although frequently referred to as 'mandibular plates', has been shown by the embryological studies of Muir, who demonstrated that all the embryonic rudiment of the mandible becomes the stylet and its attachment. Both Muir and Myers considered the lorae as part of the genae, though Imms (1925) states that they are lateral developments of the clypeus, and reference to his figure shows that the sclerite in question is the post-clypeus. It is quite certain that Imms is correct and that their attachment to the genae is a secondary development.

Myers, following Muir, regarded the ante-clypeus as the whole of the clypeus, and the post-clypeus of the cicada as the frons. This is because he was not in agreement with Snodgrass in believing that the sucking-pump is part of the mouth-cavity, but considered it to be of pharyngeal origin. The suture that divides the ante-clypeus from the post-clypeus is a secondary development and not of universal occurrence.

Maxillary Plates.—The maxillary plates have been shown by previous workers to consist of part of the maxillae, the embryonic rudiment of which becomes bi-segmented at an early stage, the basal joint becoming the maxillary plate and the distal joint the maxillary stylet.

Each maxillary plate consists of a wide, flat plate that tapers anteriorly to a point, and which is produced into the head-capsule posteriorly as an apodeme (possibly the cardo), or process, to which the maxillary stylet is attached. Although in *Hemiodoecus* the maxillary plates are distinct sclerites, in all Auchenorrhynchous families they are fused postero-laterially with the genae, and joined posteriorly by a thin membrame that lies between the floor of the hypopharynx and the base of the labium.

Labrum.—The labrum is a narrow lobe suspended from the ventral wall of the ante-clypeus, and is usually known as the labrum-epipharynx. Imms, Doering, and Branch (1913) all identify the ante-clypeus with the labrum, but the attachment of the dorsal wall of the sucking-pump to the hind portion of the former sclerite, and the fact that no suture may occur between it and the post-clypeus, render their interpretation improbable.

Hypopharynx.—The hypopharynx consists of a conical lobe that lies below the sucking-pump. Myers states that 'the lateral wings of the hypopharynx seem to be directly continuous with the lorae', which would suggest that the lorae are homologous with the superlinguae. However, though the dorsal wall of the hypopharynx is formed by the ventral wall of the sucking-pump and its support, the latter are not part of it. The salivary syringe is enclosed in the hypopharynx, and the aperture of the salivary canal is at its apex.

The hypopharyngeal apophyses are the most conspicuous structures within the homopterous head, and are probably homologous with supports of the hypopharynx such as occur in other orders.

SUCKING-PUMP.—Snodgrass has given a full and clear account of the origin and mechanism of the sucking-pump of Hemiptera, and as there appears to be no reason to doubt his interpretation, it need not be discussed here.

TENTORIUM.—The tentorium is an endoskeletal structure that serves to brace the cranial walls and give attachment to certain muscles. Snodgrass has suggested that all these muscles should take their origins on the sterna of the gnathal segments or on apodemal processes of the sterna, yet the tentorium appears to be a tergal structure. Helmsing and China have suggested that paired pits visible on the dorsal surface of each segment of the thorax of nymphs of *Hemiodoecus veitchi*, may be the ends of the thoracic apodemes similar to the frontal pits which mark the apodemes of the head. This suggestion lends support to the hypothisis that the tentorium is a tergal structure.

Considerable confusion has existed in the past over the tentorium. Myers accepted Muir's interpretation of 1926, and identified the anterior arms as the dorsal arms, although he drew attention to the fact that these arms joined the body of the tentorium, and that the latter was connected to the outer wall of the head capsule by invaginations which probably corresponded with the posterior arms of the tentorium. Although the dorsal arms of the pterygote tentorium may be united with the epicranial walls in the neighbourhood of the antennae, they are merely secondary outgrowths of the anterior arms, and can have no connexion with the posterior arms or body of the tentorium. Doering identified the tentorial arms correctly in the cercopid *Lepyronia quadrangularis* (Say), as did Snodgrass with the cicada *Magicicada septemdecim* L.

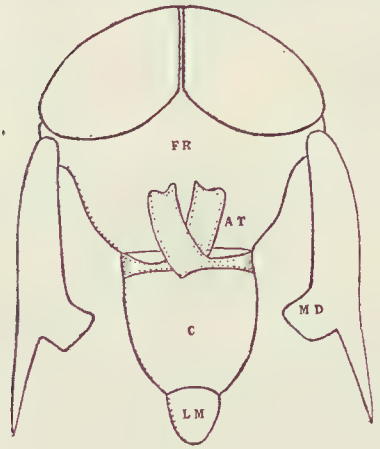
In 1929 Muir modified his views concerned with the tentorium, following the publication of a paper by Snodgrass (1928) on the morphology and evolution of the insect head, and advanced the view that the anterior arms of the tentorium arise from the hypopharynx and not from the anterior portion of the head-capsule. This assumption was based on Snodgrass's suggestion that endoskeletal arms, that spring from the base of the hypopharynx in Chilopods and Apterygota, may be homologous with the anterior arms of the pterygate tentorium. Hence Muir was of the opinion that the Hemiptera have not arisen from an orthopteroid stem, but from a more primitive one related to the Myriapoda and Apterygota.

It is, however, more probable that, whilst the hypopharyngeal apodemes of *Heterojapyx*, as figured by Snodgrass, are homologous with similar apodemes present in Hemiptera, and that apodemes

such as occur with the Machilidae (Fig. 19), which arise from the margin of the head-capsule just anterior to the epistomal suture, are homologous with the anterior arms of the tentorium of pterygote insects, the two sets of apodemes referred to are not homologous with each other.

A study of the head of *Hemiodoccus* suggests that the Hemiptera have arisen from an early orthopteroid stem, and possess, in common with the Orthoptera, sternal apophyses that arise from the hypopharynx, in addition to two pairs of tergal invaginations that give rise to the anterior and posterior arms of the tentorium.

Tentorial arms that arise from pits on the epistomal suture, such as occur in *Hemiodoccus*, must be the anterior arms and not dorsal



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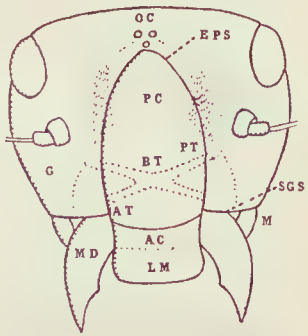

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Fig. 19.—Diagram of the head-capsule of *Allomachilis froggatti*.
Fig. 20.—Head of *Myopsocus australis*.
m., maxilla. Other lettering as in previous figures.

arms, and with their determination it is a simple matter to decide upon the homologies of similar structures in other groups, even though with the arching of the epistomal suture, the anterior tentorial pits lie at the apices of the suture and not towards its centre. In all the homopterous types examined, the posterior arms of the tentorium occur as a transverse bar, usually attached to either or both of the paired apodemes of the hypopharynx and maxillary plates. The pits of the posterior arms have not been located, but doubtless occur on the post-occipital suture, which is ill-defined, since it occurs on the membrame that separates the head from the thorax.

SUTURES.—It is believed that the various sutures that appear in the head capsule, with the exception of the post-occipital suture, have no relation to original metamerism, being only secondary inflexions of the cuticle.

Muir distinguished four sutures on each side of the head, the frontal, genal, maxillary, and labial sutures. His frontal sutures in the cicada delimited the lateral extent of the frons, continued beyond the antennae, and met in a middle line, and are thus identical with the epistomal suture of Snodgrass and the epistomal suture + clypeal suture of the present author. The apodeme of the clypeal suture, which is narrow near each antenna, and widens anteriorly, finally joining the one from the opposite side, was believed by Muir (1926) and Myers to represent the anterior arms of the tentorium; the circular membrane joining the apodemes, which forms the ventral wall of the sucking-pump or its support, was considered by them to be homologous with the frontal plate of the tentorium in some Orthoptera, and they identified the depressions that occur laterally at the junction of the ante- and post-clypeus with the pits of the anterior arms of the tentorium. Later, Muir (1929) considered the apodemes of the clypeal suture to be 'invaginations at the anterior end of the frontal suture', and not the anterior arms of the tentorium.

If it is accepted that the lorae are lateral developments of the post-clypeus, then that part of the suture that lies on either side of the post-clypeus anterior to the antennae can be neither the frontal nor the epistomal suture, but is the clypeal suture, its limit being marked by its apodeme. True frontal sutures, such as occur in *Hemiodoecus*, are elsewhere found only with fulgoroids and cercopids, where they lie on either side of the frons, and in some jassoids, where they lie between the epicranial and clypeal sutures. In the cicadas there is no trace of a frontal suture, the frons being defined laterally by the epicranial sutures, and anteriorly by the epistomal suture.

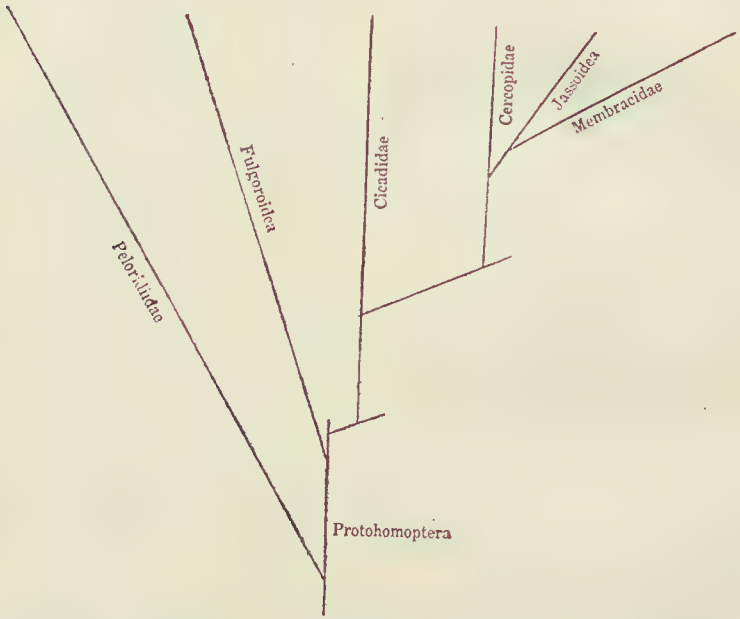
The genal sutures, which separate the lorae from the maxillary plates, must not be confused with the sub-genal sutures, since the latter, though distinct in *Hemiodoecus* and the aphides and psyllids that have been examined, are lost in other groups consequent upon the fusing of the genae with the maxillary plates.

The maxillary suture of Muir is 'very indistinct, and only recognizable as a crease'; it lies on the other side of the maxillary plate from his genal suture. Muir regarded the processes of the maxillary plates which lie alongside the apophyses of the hypopharynx, and which may be fused with the tentorial bar, as being the apodemes of the maxillary suture, and since he stated that the maxillary apodeme 'is the most complex and conspicuous structure in the head of the

cicada', it would seem that he had failed to separate the processes of the maxillary plates, to which the maxillary stylets are joined, from the apophyses of the hypophraynx.

The labial suture of Muir must be homologous with the post-occipital suture, since on it occur the pits of the posterior arms of the tentorium.

Only one more suture need be considered: that is the epistomal suture, which separates the frons from the clypeus. Snodgrass identified the suture that lies at the back and sides of the large median swollen sclerite in psocids and cicadas as the epistomal suture. Whilst not disputing this interpretation in so far as psocids are concerned, where no clypeal suture occurs, it is maintained that in



cicadas the epistomal suture extends anteriorly only as far as the neighbourhood of the antennae, where it meets the clypeal suture, which, as has been mentioned in an earlier paragraph, may be recognized by its apodeme. The anterior tentorial pits occur at the junctions of the two sutures. With cercopids the epistomal suture is seldom distinct, whilst with most jassoids no trace of it remains in adult insects, the posterior margin of the fronto-clypeus being limited by the epicranial suture.

PHYLOGENY.—Various views have been advanced in the past concerned with the phylogeny of the Auchenorrhyncha. Osborn (1895) considered the Cicadidae to be the most generalized, followed by the

Membracidae, Fulgoroidae, Cercopidae, and Jassoidea, in that sequence. Kirkaldy (1906), whilst in agreement with Osborn in so far as the position of the Cicadidae was concerned, believed the fulgoroids to be the most specialized, and linked the membracids closer to the cercopids than to the jassoids. Singh-Pruthi (1925), as a result of a study based on the characters of the male genitalia, derived the Fulgoroidea from a lower level of the homopterous stem than the other groups, and the Membracidae from the same line as the Jassidae and Cercopidae, but at a lower level. The possible relationships of the various groups, as suggested by a comparison based principally on head-structure, are set out in the phylogenetic tree given above.

After the Peloridiidae, the Fulgoroidea are derived from the lowest level of the protohomopterous branch, not only because in the structure of the head, especially the clypeus, they resemble *Hemiodoecus*, but because of the primitive type of their genitalia, no subgenital plates being developed, and also on account of their tegminal venation. Certain fulgoroid genera have more complete venation, and less specialization by reduction, than is found in any other group of homoptera.

After the Fulgoroidea, there is little doubt that the Cicadidae represent the most primitive family, and next to them come the Cercopidae, which are possibly related to the mesozoic Scytinopteridae, since the tegminal venation of the latter is very similar to that of the present-day Machaerotinae.

The Cercopidae resemble the Cicadidae in the complete development of the tentorium, and in the presence, with many genera, of a distinct frons. The Jassoidea and Membracidae are placed at a higher level than the Cercopidae, because of their reduced tentorium, and since it is believed that the fusion of the post-clypeus with the frons, and in some genera the fusion of the front-clypeus with the vertex, is a recent development, brought about by the progressive backward migration of the dilator muscles of the sucking-pump on the cranial walls.

References.

Baker, C. F., 1923.—The Jassoidea related to the Stenocotidae. *Phillipine Journ. Sci.* 23 (4); 348.

Branch, H. E., 1913.—Morphology and Biology of the Membracidae of Kansas. *Kansas Univ. Sci. Bull.* 8 (3).

China, W. E. 1932.—On the Occurrence of the Peloridiid Genus *Hemiodoecus* in Queensland. *Ann. & Mag. Nat. Hist.* (10), 10; 392.

Comstock, J. H., 1920.—*An Introduction to Entomology.* Comstock Publishing Co., Ithaca, N.Y.

Doering, K., 1922.—Biology and Morphology of *Lepyronia quadrangularis. Kansas Univ. Sci. Bull.* 14 (21).

Evans, J. W., 1937,—(*a*) Australian Leaf-Hoppers, Pt. 5. *Papers Roy. Soc. Tas.* 1936, 69.

EVANS, J. W., 1937.—(*b*) A New Species of Peloridiidae from Tasmania. *Proc. Roy. Ent. Soc. London.* B. 6 (6); 107.

HELMSING, I. W., and CHINA, W. E., 1937.—On the Biology and Ecology of *Hemiodoecus veitchi*. *Ann. & Mag. Nat. Hist.* (10), 19; 473.

IMMS, A. D., 1925.—*A General Text Book of Entomology.* Metheun and Co., London.

KIRKALDY, G. W., 1906.—Leaf-Hoppers and their Natural Enemies. *Bull. Hawaii Sug. Ass. Ent.* 1 (9).

MUIR, F., 1926.—Reconsideration of Some Points in the Morphology of the Head of Homoptera. *Ann. Ent. Soc. America.* 19; 67.

————, 1929.—The Tentorium of Hemiptera Considered from the Point of View of the Recent Work of Snodgrass. *Ent. Month. Mag.* 65; 86.

MYERS, J. G., 1928.—The Morphology of the Cicadidae. *Proc. Zool. Soc. London.* (2), 365.

————————, and CHINA, W. E., 1929.—The Systematic Position of the Peloridiidae. *Ann. Mag. Nat. Hist.* (10), 3; 282.

OSBORN, H., 1895.—The Phylogeny of the Hemiptera. *Proc. Ent. Soc. Washington.* 3; 185.

SING-PRUTHI, H., 1925.—The Morphology of the Male Genitalia in Rhynchota. *Trans. Ent. Soc. London;* 127.

SNODGRASS, R. E., 1928.—Morphology and Evolution of the Insect Head and Its Appendages. *Smithsonian Misc. Coll.* 81 (3), no. 20.

————————, 1935.—*Principles of Insect Morphology.* McGrath Hill Book Co.

Pap. & Proc. Roy. Soc. Tasmania, 1937 (20th May, 1938)

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The Tasmanian Brush Opossum: Its Distribution and Colour Variations[1]

By

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(Read 8th November, 1937)

Plates I-III

The present investigation was undertaken with the object of inquiring into the significance of the colour variations of the Tasmanian Brush Opossum, *Trichosurus vulpecula fuliginosus* Ogilby. The main investigation has not proceeded very far, and it is clear that elucidation of the genetical aspect of the problem will entail several years of experimental work. In the present paper the results of the preliminary inquiry are put on record, since they throw light upon the distribution and relative abundance of the two principal colour groups of *T. v. fuliginosus*.

Trichosurus vulpecula vulpecula Kerr, 1792, is found in Southern Queensland, New South Wales, Victoria, and South Australia. It varies in colour from the well-known silver-grey to the bluish-grey Monaro phase of the southern highlands and the yellow-bellied greyish animal of the north-west.

According to Iredale and Troughton (1934) there are seven varieties of the main species: one in Tasmania, three in Queensland, one in the Northern Territory, and two in Western Australia. These varieties have been partly established on colour characters, and it is found that the typical grey gives place to reddish, reddish-brown, brown, and black. I can find no exact statements as to what extent the grey individuals are found, if at all, along with the other colour variants. It would appear reasonable to believe, however, that grey was the original colour of this form, and that the melanistic departures from this colour are more recent developments.

[1] A contribution to the Biological Survey of Tasmania.

In the case of the Tasmanian sub-species *Trichosurus vulpecula fuliginosus* Ogilby, there are two main colour forms, generally referred to as 'grey' and 'black'. Although each of these main divisions exhibits within itself many colour variations there is no difficulty in distinguishing a grey from a black.

'Grey' Opossum.—In the case of the 'grey' the tail is invariably black from the tip for about two-thirds or three-quarters of its length, and the proximal part has the same grey colour as the posterior part of the body. The posterior half of the body is generally a true grey, either dark, medium, or light. In some cases the anterior half is the same colour, but more frequently there is a tawny or brownish tinge.

'Black' Opossum.—The tail is uniformly coloured dark-brown or black. The posterior half of the body usually has the same colour as the tail. The anterior half may be of the same colour as the posterior, but more frequently there is a tawny or reddish tinge.

In both greys and blacks the individual hairs are lighter at the base and darker at the tip.

Nothing is known of the genetical significance of the two colours. Wood Jones (1924) states that the melanistic variety which occurs among the ordinary grey forms in South Australia is the offspring of ordinary grey parents. Mr. Brazenor, Mammalogist of the National Museum, Melbourne, has confirmed this from his personal knowledge. In view of the interesting distributional results obtained in the course of the present preliminary investigations it would appear to be necessary to make exhaustive genetic experiments with the greys and blacks in order to determine the true significance of the colour characters.

The preliminary investigations have been pursued along the following lines:—

1. To determine what other characters, if any, are associated with the two main colour groups. For this purpose body measurements and skull measurements have been taken.
2. To ascertain the relative abundance of the two main colour groups in different parts of Tasmania.

Body Measurements

At the present stage it has not been possible to make a sufficiently large number of measurements of freshly killed animals, but advantage was taken of the open season in 1937 to measure 318 greys and 260 blacks after the skins had been pegged out and roughly cured by trappers. This method is unreliable if accurate body

measurements are required, as the pelt becomes stretched and distorted to some extent. Nevertheless, as a comparative method the measurement of dried skins probably has some value, and it is probable that the relation of the length of the tail (T) to the length of the body (L) is fairly reliable. In Table I an analysis of the results of measuring 578 dried skins is given. It will be seen from this table that $\frac{T}{L}$ varies in the greys from 47·2 per cent. to 60·6 per cent., with a mean percentage of 53·9. In the blacks $\frac{T}{L}$ varies from 48·3 per cent. to 58·5 per cent., with a mean percentage of 52·9. There is nothing in these figures to indicate that coat colour is correlated with the body measurements I have used. It is true that the number of skins measured was relatively small.

Table I

Body Measurements.

Brush Opossum (Grey)

Number of Specimens	*District*	*Average Length from Snout to Base of Tail (L) cm.*	*Average Length of Tail (T) cm.*	$\frac{T}{L}$ x 100
				%
1	Port Davey	61·0	37·0	60·6
2	Mt. Barrow	58·5	35·0	60·0
3	Tasman Peninsula	63·0	35·3	56·1
41	Weldborough	63·5	35·4	55·8
75	Epping	62·4	34·5	55·3
14	Mt. Misery	67·6	36·5	55·0
21	Forrester Settlement (Scottsdale)	62·6	34·2	54·7
4	East Coast	64·2	34·7	54·0
9	West Coast Road	67·8	36·1	53·2
2	Huon	70·0	37·2	53·1
6	Swansea	63·8	33·7	52·8
55	Scottsdale	63·9	33·3	52·2
15	Mt. Roland	65·5	33·7	51·5
56	Ben Lomond	63·4	32·1	50·7
5	Dunorlan	68·5	34·5	50·5
6	New Country	63·0	31·7	50·4
3	Great Lake	67·3	31·7	47·2

Average of 318 = 53·9%

Brush Opossum (Black)

2	Port Davey	65·0	37·0	58·5
7	Ben Lomond	59·3	33·3	56·2
14	Dunorlan	64·4	36·1	56·2
27	Forrester Settlement (Scottsdale)	62·9	34·9	55·5
21	Mt. Barrow	67·4	37·3	55·4
14	Mt. Misery	66·4	36·4	54·8
38	Epping	64·9	34·6	53·5
32	Mt. Roland	64·4	34·1	53·0
2	Great Lake	65·7	34·7	52·9
10	Brown Mountain, Runnymede	62·0	32·5	52·5
75	Scottsdale	64·7	32·7	50·6
8	Huon	70·4	35·3	50·2
4	East Coast	67·2	32·7	48·7
4	West Coast Road	74·7	36·0	48·3

Average of 260 = 52·9 %

Skull Measurements

In Table II certain skull measurements are given. These measurements were taken to ascertain if any correlation could be discovered between size and proportion of the skull on the one hand and coat colour and sex on the other. As only 27 skulls were examined, it is clear that too much reliance should not be placed upon these results, but the measurements serve to show, as far as they go, that in each of the characters examined there is considerable variability, and there is no indication that any particular skull character is linked with coat colour or sex.

Table II

*Skull Measurements**

	Sex	A	B	C	D	E	F
		mm.	%	%	%	%	%
Brush Opossum (Grey)							
A54/756	♂	73	56·1	43·8	20·5	56·1	78·1
A50/752	♂	81	69·1	48·1	19·9	60·5	76·5
A51/753	♂	83	67·5	42·2	19·3	56·6	72·3
A52/754	♂	91	67·0	45·0	19·8	57·1	74·7
A56/758	♂	77	66·2	45·4	24·9	58·4	72·7
A30/760	♂	84	70·2	47·6	20·2	59·5	73·8
A31/761	♂	83	69·3	45·8	20·5	57·8	75·9
A55/757	♂	85	68·2	45·3	21·2	58·8	76·5
A29/759	♂	78	69·2	46·2	21·8	59·0	79·5
A49/759	♀	87	66·6	45·4	20·7	55·7	74·7
A46/776	♀	75·5	70·2	42·4	19·9	57·6	78·0
A47/749	♀	80	68·7	40·6	21·2	56·2	78·7
A33/763	♀	72·5	69·0	44·1	20·7	58·6	78·0
A39/769	?	64·0	70·3	35·8	21·9	57·8	78·1
A36/766	?	81·0	67·9	46·9	19·7	58·6	76·5
A38/768	?	85	68·2	44·7	20·0	56·5	74·1
A35/765	?	78	71·1	42·3	19·2	57·7	73·1
A37/767	?	81	65·4	43·2	17·9	55·5	72·2
Brush Opossum (Black)							
A45/775	♂	81	69·1	45·7	21·0	58·0	75·3
A34/764	♂	79	70·9	44·3	20·9	56·3	78·5
A48/750	♂	86	68·6	43·0	19·8	58·1	74·4
A53/755	♂	87	65·5	44·8	18·4	56·3	76·4

* See next page.

TABLE II—*continued*

SKULL MEASUREMENTS: BRUSH OPOSSUM (BLACK)—*continued.*

	Sex	*A*	*B*	*C*	*D*	*E*	*F*
		mm.	%	%	%	%	%
A40/770	♀	83	67·5	43·4	19·3	57·8	73·5
A41/771	♀	76	70·0	44·7	20·4	58·4	73·7
A43/773	♀	82	66·5	46·3	20·7	56·7	75·6
A42/772	♀	88	69·3	46·6	20·4	54·5	77·3
A44/774	♀	81	67·9	44·4	21·0	56·8	74·1

* A = Basal length.
B = Zygomatic breadth (across the posterior ends of the Jugals).
C = Length of Nasals along middle line.
D = Greatest breadth of Nasals.
E = Length of palate (from the delicate bar forming the posterior boundary of the Posterior Palatine Foramen to the anterior end of the Pre-maxilla).
F = Along median dorsal line, from the posterior edge of the Sagittal Crest to the point of intersection of a line joining the Lachrymal foramina.
B-F are expressed as percentages of the basal length (A).

RELATIVE ABUNDANCE OF THE TWO COLOUR GROUPS

The figures of the Brush Opossums captured in the open seasons of 1934 and 1937 have been analysed. 58,407 records for 1934 and 47,528 for 1937 have been examined. These are summarised in Table III.

It will be seen that the main Bass Strait islands (Flinders Group and the King Island Group) have 100 per cent. greys. On the main island of Tasmania an interesting state of affairs is presented. This can best be appreciated by an examination of Plate I, in which the figures of Table III are plotted.[1] It is seen that the highest percentage of greys is to be found on a strip extending from the East Coast to the Central tablelands, and also in the isolated Tasman-Forestier Peninsula. From this central zone the percentage of greys gradually decreases, and we find a remarkably low percentage of greys in the two remotest districts, viz., in the region north of the Arthur River in the north-west corner of Tasmania, and in the Huon district in the south. No specimens have been recorded from the Arthur-Pieman Reserve, but I have been assured by Mr. Wigg, of the Animals and Birds' Protection Board, that there are no greys in that area. On his authority I have labelled the reserve 'all black' in Plate I. No information is available for the south-west corner of Tasmania, but it is reasonable to assume that there would be a low percentage of greys in that region.

[1] Separate maps for 1934 and 1937 are not given, as it was found that the results of these two years agree in a marked manner, and the distributional map given in Plate A, though dealing with the combined years 1934 and 1937, might be taken for either of these years.

TABLE III

Distributional Records

	1934		1937		%
	Grey	*Black*	*Grey*	*Black*	*Greys*
Bass Strait Islands	5697	—	3775	—	100
Great Lake District	3124	445	1486	152	88·5
Tasman and Forestier Peninsulas	896	183	—	—	83·1
St. Marys District	1069	256	1523	348	81·4
Tunbridge-Ross-Campbell Town	1627	364	1729	395	81·4
Hamilton-Ouse-Dee	1846	470	937	177	81·0
Cradle Mt.-Western Tiers	244	59	—	—	80·5
Oatlands District	1081	305	3820	1042	78·6
Westbury-Deloraine-Mole Creek	1842	554	2754	736	78·3
Bothwell-Apsley District	990	255	1298	486	75·4
Ben Lomond-Mathinna-Fingal	481	246	1328	397	73·6
Lake Leake-Bicheno-Swansea	1459	503	1147	425	73·5
Copping-Campania-Runnymede	351	146	2334	907	72·0
Cressy-Epping-Evandale	1577	505	1412	623	71·5
Nile-Epping	1100	388	1423	623	71·5
Avoca District	3715	1644	905	242	71·0
New Town-Bridgewater (North Hobart)	1755	740	—	—	70·3
Cleveland-Conara	59	25	—	—	70·1
Newnham District (Launceston)	543	238	—	—	69·5
East Tamar-Piper's River-Bridport	317	183	155	33	68·6
Little Swanport-Buckland	569	262	—	—	68·3
West Tamar District	797	399	168	56	68·0
Mt. Barrow-Lilydale	507	257	124	60	66·8
Middlesex-Moina-Lorinna	748	416	—	—	64·0
Kempton-Tunnack	180	81	272	176	63·6
Meander District	515	297	—	—	63·4
St. Helens-Ringarooma-Pioneer	1489	892	1437	833	62·9
Lindisfarne-Rokeby	52	31	—	—	62·5
Boobyalla-Gladstone-Anson's Bay	272	157	524	376	59·9
Hayes-Brighton-Mt. Direction	341	206	53	70	58·8
Eldon Range-Franklin River-Zeehan	1389	841	396	447	58·0
Tunnel-Scottsdale	859	605	978	816	56·4
Latrobe-Kimberley-Harford	340	271	62	72	53·0
Nietta-Sheffield	487	510	934	822	51·6
Fentonbury-Macquarie Plains	223	212	—	—	51·5
Gunn's Plains-Sprent-Nook	235	304	—	—	43·6
Collinsvale-Uxbridge	73	178	203	333	35·0
Adamsfield-Florentine River	189	362	—	—	34·4
Ellendale-Fitzgerald-Uxbridge	269	514	68	144	33·8
Wynyard-Ulverstone (back country)	304	622	551	2061	24·1
Waratah	79	238	11	67	22·8
Calder-St. Valentine's Peak	13	64	—	—	16·9
North and East Sides of Huon Estuary	120	895	107	634	12·9
South and West Sides of Huon Estuary	113	891	80	609	11·4
Rocky Cape-Black River-Myalla	42	326	3	73	10·1
Huonville-Fern Tree	49	561	—	—	8·0
Yolla-Henrietta-Preolenna	1	20	—	—	4·8
Montagu-Marrawah-Smithton	47	411	3	1293	2·9
Total	40,075	18,332	32,000	15,528	
	58,407		47,528		
	105,935				

1934		1937	
Grey	*Black*	*Grey*	*Black*
68·6%	31·4%	67·3%	32·7%

General Considerations

It is perhaps premature to venture an explanation of this very interesting distribution of the two main colour forms of the Tasmanian Brush Opossum.

If the present depth-contours of Bass Strait are any indication of a former land connexion between Tasmania and the mainland of Australia, we can envisage that connexion as having followed the Wilson's Promontory-Flinders Island line. If the floor of Bass Strait were raised about 30 fathoms there would be a narrow strip of land connecting Wilson's Promontory with the north-east corner of Tasmania (see Plate III).[1] King Island would be connected with the north-west corner of Tasmania, and would be separated from the Wilson's Promontory-Flinders connexion by an enclosed basin having a narrow inlet at its north-west corner into the Bight. Such a land connexion would have enabled the grey Brush Opossum of South-Eastern Australia to reach the Tasmanian land-mass at its north-eastern corner. This agrees in the main with the character of the present distribution of the Brush Opossum in Tasmania. The melanistic type, so rare on the mainland, is also rare at the presumed point of entry of the species into Tasmania (i.e., at the north-east corner), but becomes increasingly abundant in a westerly and south-westerly direction. Thus, in Flinders Island only greys are found; on the east coast the greys predominate; in the extreme north-west and south-west the greys are very rare.

A difficulty to the acceptance of this hypothesis, however, presents itself. At the time the Bassian isthmus existed King Island was presumably linked up with the north-west corner, and should have shared with that area in the possession of a preponderance of blacks. In point of fact, however, King Island, like Flinders Island, possesses no blacks.

King Island, then, with 100 per cent. grey, is strikingly different from the north-west corner of Tasmania, which has nearly 100 per cent. black. Does this point to the fact that these two regions were not connected, as the present contour of the sea-bed between King Island and the North-West Coast would lead us to suppose? In spite of the deep water between King Island and the mainland and between King Island and Flinders Island, is it likely that King Island received its Brush Opossums direct from the mainland or through a connexion with Flinders Island?

An alternative suggests itself. If we are forced to the conclusion that the Bass Strait depth-contours give a correct indication of the shape of the former land-mass, it may be that when the grey form reached Tasmania it spread over the whole country

[1] The same effect would be produced by the lowering of the sea-level by the same vertical distance. Edgeworth David (1924, p. 139) stated that in the last Pleistocene glaciation the sea-level was lowered by 200 feet owing to the locking up of enormous volumes of sea water, which went to form some eleven millions of square miles of Pleistocene ice-sheets.

as a grey animal, and that only at a subsequent period, after King Island had become separated from Tasmania, did the melanistic form assume importance and gradually supplant the greys in certain districts. There does not appear to be much support for this view, and in spite of the King Island problem I prefer the view that the blacks became more abundant as the Brush Opossum migrated farther and farther away from the point of entry.

At the present stage of the investigations it would appear unprofitable to attempt to arrive at any solution of this very intriguing problem. The outstanding difference between the entire absence of blacks from King Island and the predominance of blacks in the north-west of Tasmania furnishes an enigma which appears difficult to explain in the light of our present knowledge.

The greys and blacks can hardly be designated geographic races specially adapted to the particular district in which they are found, since they live side by side in nine-tenths of the Tasmanian area. Nevertheless it is true that the blacks gradually increase in proportion towards the west and south. This state of affairs cannot be explained at present by the environmental conditions prevailing in the different parts of Tasmania, though no doubt an explanation will ultimately be found when we know these conditions more accurately. Two important factors, namely, elevation and rainfall, do not seem to affect the issue. A comparison of the maps given on Plates I and II would seem to indicate that there is no correlation between the relative abundance of greys and blacks in different parts of Tasmania and the incidences of elevation and rainfall. It is true that, generally speaking, a higher percentage of greys is found in the drier eastern districts, but this generalized statement will not bear close analysis, since the highest percentage of blacks is found in the north-west corner and the Huon district where the rainfall is not abnormally high.

Nevertheless it is interesting to note that Shull (1936) has drawn attention to the fact that many mammalogists believe that relative humidity affects coat colour, and it is thought that darker races are produced in more humid regions.

Neither do elevation contours offer any explanation of the interesting relative distribution of greys and blacks. This will be clearly realized by an examination of Plate I with Plate II, fig. 1.

Although the greys and blacks are so clearly defined there are so many grades of greys and blacks that it would appear that we are not dealing with two simple allelomorphs based upon one pair of genes. It is possible that there is one chief pair and several modifying pairs of genes. The genetic explanation of this problem promises to be a complicated one, and this aspect will not be dealt with in the present preliminary survey. It is proposed to carry out breeding experiments in the hope that more light will be thrown upon this interesting problem.

Acknowledgements

I am indebted to Mr. E. O. G. Scott, B.Sc., of the Queen Victoria Museum, Launceston, for assisting me in measuring the skins of Brush Opossums; to Messrs. Wilcox, Mofflin Ltd. and Neale Edwards Pty. Ltd. for offering facilities for examining skins and for giving valuable information regarding the distribution and colour varieties of the Brush Opossum; to Mr. A. L. Meston, M.A., for procuring opossum skulls; to Mr. E. le G. Troughton, of the Australian Museum, Sydney, to Mr. E. W. Brazenor, of the National Museum, Melbourne, and to Mr. H. H. Finlayson, of the University of Adelaide, for their help in regard to the colours of the mainland sub-species of *Trichosurus vulpecula;* to Mr. P. Wigg, of the Tasmanian Animals and Birds' Protection Board, for advice on the habits and distribution of the Brush Opossum; to Capt. Pearse for making the charts which illustrate the present paper; to Mrs. Lord and Mr. R. Boswell, of the Tasmanian Museum and Art Gallery, for assisting me in the arduous work of analysing over 100,000 opossum records; and to the Commissioner of Police for Tasmania for placing at my disposal the records of Brush Opossums captured during the 1934 and 1937 open seasons.

References

David, Sir T. W. Edgeworth, 1924.—Geological Evidence of the Antiquity of Man in the Commonwealth, with Special Reference to the Tasmanian Aborigines. *Pap. Roy. Soc. Tasm.* 1923. pp. 109-150.

Iredale, T., and Troughton, E. le G., 1934.—A Check-list of the Mammals Recorded from Australia. *Memoirs of the Australian Museum, Sydney,* No. 6.

Jones, F. Wood, 1924.—The Mammals of South Australia, Part II. pp. 196-203.

Shull, A. F., 1936.—Evolution. *McGaw Hill Book Co., New York.*

PLATE I

Map of Tasmania showing relative distribution of Brush Opossums.

The large figures indicate the percentage of greys in different zones. The smaller figures mark the percentage of greys at individual stations.

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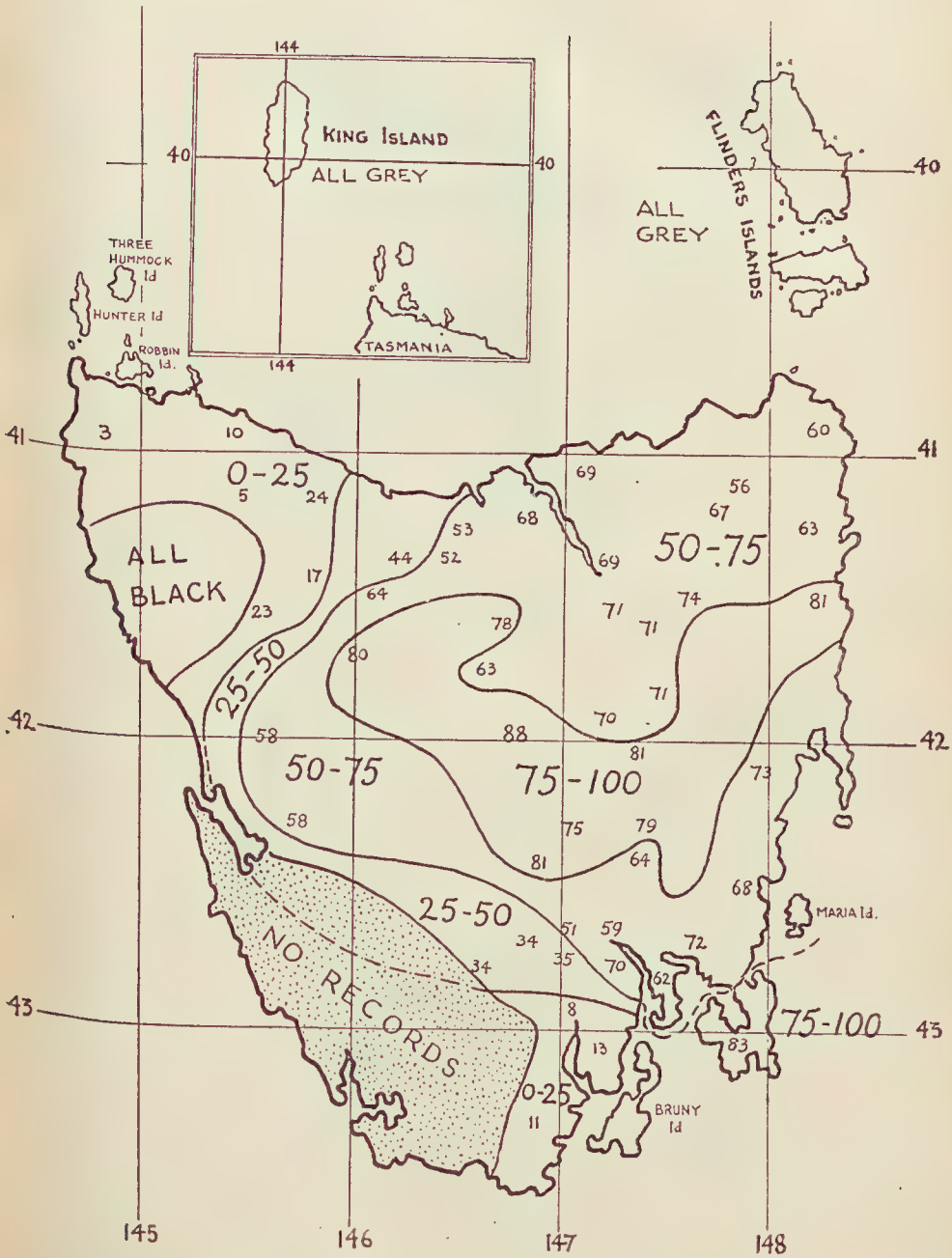
KING ISLAND
ALL GREY
TASMANIA
144
40
FLINDERS ISLANDS
ALL GREY
THREE HUMMOCK Id
HUNTER Id
ROBBIN Id.
41
42
43
0-25
ALL BLACK
25-50
50-75
75-100
NO RECORDS
MARIA Id.
BRUNY Id
145
146
147
148

PLATE II

FIG. 1.—Elevation contours in Tasmania.
FIG. 2.—Distribution of rainfall (in inches) in Tasmania.

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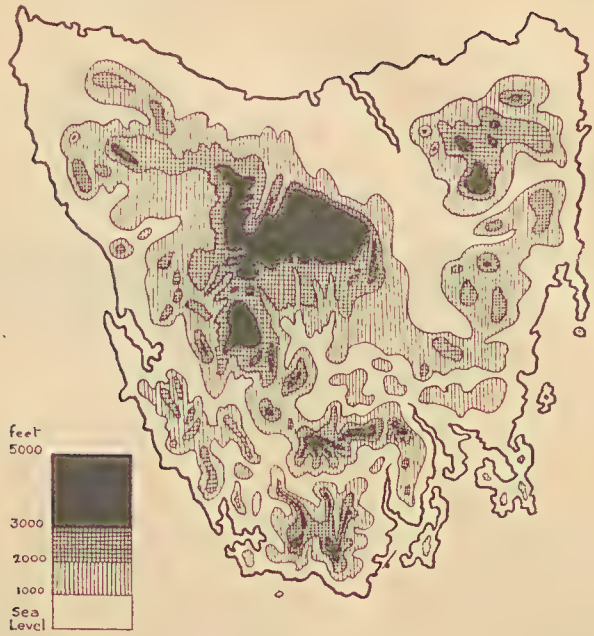
feet
5000
3000
2000
1000
Sea
Level

Fig. 1

40
50
30
30
40
50
60
40
30
20
30
20
100
60
80
80
60
50
NO RECORDS
30
40

Fig. 2

PLATE III

Map of Bass Strait showing the present land outline (black), and the increased area (dotted portion) which could be produced by raising the sea-bed by 31 fathoms, thus indicating a probable former land connection between Tasmania and the continent.

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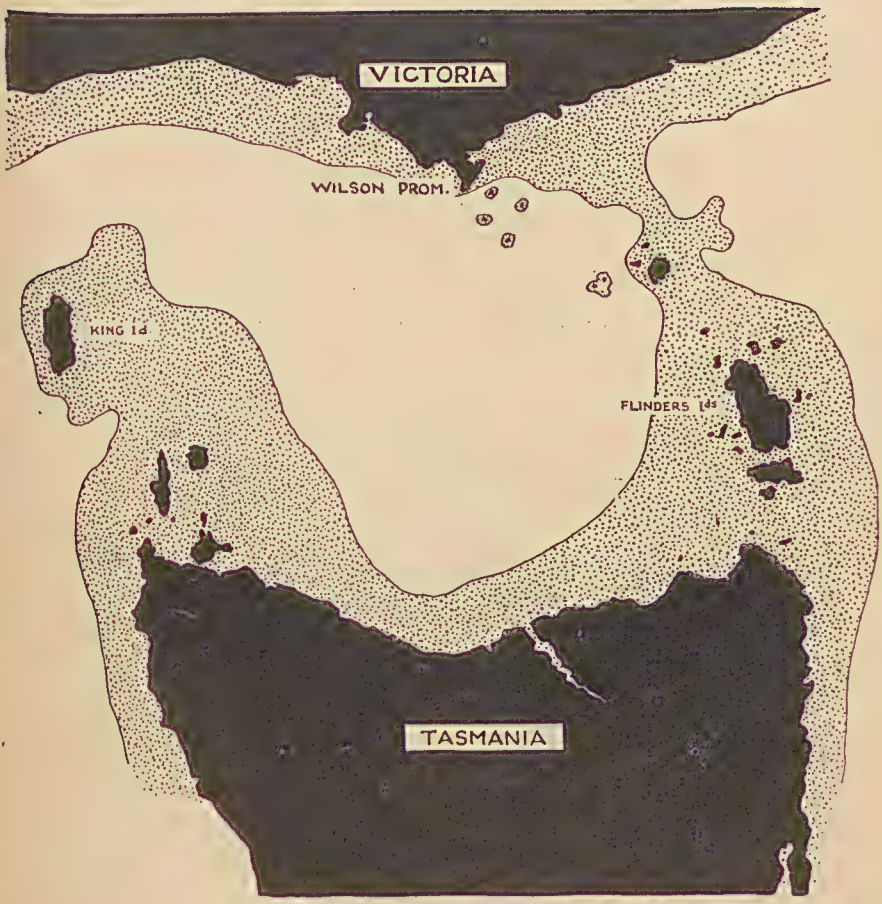
VICTORIA
WILSON PROM.
KING Id
FLINDERS Ids
TASMANIA

A Record of Volcanic Activity in Tasmania During Triassic Times

By

A. N. Lewis, M.C., E.D., LL.D., M.H.A., and
A. H. Voisey, M.Sc.

(Read 8th November, 1937)

Plate IV

Part I.—Field Occurrence

By

A. N. Lewis

There has been no previous record of volcanic activity in Tasmania during the period occupied by the deposition of the coal-bearing rocks of Permian-Triassic age. Certain layers of flinty rock interbedded in the New Town coal measures used to be considered to be metamorphic products from contact with the intrusive dolerite. Whilst working on the occurrences of the dolerite in this area, I formed the opinion that these hard layers could not possibly be related to the dolerite intrusions, and they appeared to have been directly deposited in the sequence now visible. I took advantage of the presence in Hobart in March, 1937, of Mr. Alan H. Voisey, of the Sydney University, who has had considerable experience amongst the tuffs of New South Wales, to examine the layers in question. Mr. Voisey confirmed my suspicions of the existence of tuffs in the New Town coal measures, after a few minutes' inspection. He has been good enough to make a detailed petrological examination of specimens I selected as representative types. The result is a contribution to Tasmanian geology of outstanding significance, and workers in this State must be grateful for Mr. Voisey's interest and labours.

Locality of the Occurrence

The rocks which are the subject of this paper, and which will be referred to collectively as the *New Town Tuffs*, were found in the quarry now worked by the Hobart Brick Company, No. 110 Giblin-street, New Town, directly opposite the north-western terminus of Pedder-street. (Lewis and Murray's Map of Hobart, 1 inch = 1m — 052743.) This is near the *Adit* and *Brook's Engine Shaft* marked on Krause's Chart (Krause, 1884), and, as far as I can identify from the vague descriptions now extant, part of the workings of the Enterprise Coal Mining Company.

This quarry-face has now been cut back some 75 yards from the drainage creek which runs just north-west of Giblin-street and about 125 yards from the street. As the quarry is continually extending it is difficult to give a more exact datum. The tuffs are exposed from the floor of the quarry upwards for some 30 feet. The strata dip at about 10 degrees to the south-west, and thus the tuffs hitherto identified disappear beneath the overlying coal measures and sandstones within the short distance occupied by the quarry. No exposures exist further north or north-west where, a short distance away, a mass of dolerite abuts on the sedimentary series.

I have carefully examined the very meagre exposures in road-cuttings through the New Town basin and the better sections along the face of Knocklofty without tracing any further occurrences of tuff, and several specimens of doubtful appearance from these areas, and also from the sandstones between the 1450 and 2500 feet contour round Mt. Wellington, were all pronounced by Mr. Voisey to be of purely sedimentary origin. However, I have located another tuff of distinctive and almost scoriaceous appearance interbedded in the fresh-water shales of Spring Hill. This layer is about 24 inches in thickness, and is to be seen in the large sidling one-quarter of a mile north of Timsbury House. No other occurrence of tuff was discernible in the sections between Melton and the top of Spring Hill.

Geological Horizon of the Tuffs

The rocks in question occur in the New Town coal basin, a typical member of the upper coal measures of Tasmania. The beds of tuff are in intimate association with shales replete with a rich equistaceous flora. Splendid specimens of *Neocalamites* cf. *carrerei* Zeiller; *Phyllotheca australis* Brongniart; *Schezoneura* sp.; and many unidentified pith casts are to be found within inches above and below the tuffs. *Johnstonia coreacea* Johnston is very common in the section exposed by the quarry, with *Cladophlebis australis* Morris less common, and rich *Thinnfeldia odontopteris* Morris beds in the higher levels some 20 feet above the topmost identified layer

of tuff. The rich cycad flora of Lord's Hill, a half-mile further south, is not to be seen at Giblin-street, and appears to be a slightly higher horizon. From this evidence the beds may be located near the top of the Rhaetic (Upper Triassic) (Walkom, 1926). They are not at the top of the coal measures, which may possibly just extend into the Jurassic System, and therefore Upper Triassic appears to be a reasonably safe determination.

The location of these rocks within the Tasmanian coal measures is more difficult, and, until I have completed my work on the Geology of Hobart, I am not quite prepared to say more than that the tuffs appear to be rather low in the coal-bearing series as developed in this area. The Geological Survey, in the *Coal Resources of Tasmania*, appear to have assumed that during the period of deposition Tasmania was one geographical unit, to the extent that each coal-seam was deposited over the whole country at the same time, and that seams in different places can be correlated by palaeontological groupings. Without stressing the point here, my observations lead me rather to the view that many separate coal basins were in existence, and it is impossible to arrive at a correlation, seam or stratum for seam and stratum, from one basin to another; also, that the plant life responsible was governed by environmental factors, so it is dangerous to rely on any particular grouping within the series as a basis of correlation; further, that the rocks which have been termed the *Felspathic Sandstones*, with the included coal measures, were deposited in a relatively brief space of time, during which there was no marked floral change sufficient to give a definite zoning key within the series. Fossil groupings are certainly very useful for correlating or differentiating several seams within one basin, but cannot be used in the same way between different basins.

I cannot accept, therefore, the Geological Survey's correlation of these coal measures as final, and previously published sections appear to me to be open to doubt, owing to the failure to have due regard for the many faults which occur in the area. At present, I am inclined to the view that the Knocklofty sandstones overlie the coal measures, but there is certainly a fault of some magnitude between the two beds. As far as my investigations carry me, I consider that the New Town coal-seams lie high in the felspathic series, and that the tuffs are within 200 feet of the top of the coal measures as developed in this area. This view, however, is not finally proved.

Previous Accounts of the New Town Coal Fields

Considering its accessibility and interest this area has received scant attention from geologists. In 1883 Mr. G. Thureau made a very brief report, which contains no information of present interest. In 1884 Mr. F. M. Krausè advised against drilling for coal. His report contains a map, which is virtually the only published account

of the geology of New Town. He also added a detailed section. This, however, is hypothetical, in that it is based on a measurement of surface features. As Krausè failed to recognize the great Knocklofty Fault, with its throw in the neighbourhood of 2000 feet, and which separates the Permian mudstones from the Triassic coal measures, his section is worthless except as to the coal measures themselves. R. M. Johnston virtually copied Krausè's report into his *Geology of Tasmania*, and the Geological Survey did the same in 1922. (The geological map referred to on page 171 of *Coal Resources of Tasmania* does not appear to have been published.) R. M. Johnston did wonderful work in collecting and describing the fossil flora of the locality but contributed little towards a knowledge of its structural geology. (See, e.g., Johnston, 1886.)

Field Occurrences of the New Town Tuffs

The rocks described in this paper have only been identified from the Hobart Brick Company's quarry and within a vertical range of about 30 feet by a horizontal distance of 50 yards. The identification should therefore not be generalized as typical of the series.

Three types easily distinguishable to the naked eye were found, these being described respectively as—

No. 1.—Greenish tuff. A soft greenish-brown rock, speckled with dark-green to black spots. No harder than the surrounding shale and only distinguishable in the field by its colour.

No. 2.—Yellow tuff. A very hard rock, somewhat resembling a quartzite in hand specimens, and clearly distinguishable by its hardness, which necessitates it being hand-picked from the quarried material before crushing for brick-making. Its colour is predominantly a dull buff.

No. 3.—Grey tuff. A bluish-grey rock, usually harder than the surrounding shale, but softer than No. 2. It is frequently impregnated with carbonaceous matter, which is sometimes well preserved as fossils.

All the above types occur in repeating layers. They are exactly interbedded with the fossiliferous shales of the coal measures. The average thickness is six inches, but twenty-four inches is attained in at least one layer. In many cases they merge sometimes at the top, sometimes at the bottom, sometimes on both sides, of the tuffaceous layer into normal freshwater shales. Sometimes the separation from shale to tuff is very clearly marked. The tuffs form one bed with the shales, and the difference is not easy to identify at the distance of a few yards. It is quite clear that both rocks followed each other in a normal sequence of deposition. In at least one layer of grey tuff (No. 3) the volcanic material overwhelmed growing plants.

W. H. Twelvetrees noted a peculiar rock in the coal-bearing strata at South Cape Bay. The present writer has examined these occurrences, and expresses the view that they are probably water-worn blocks of tuff or volcanic bombs of tuffaceous material. (Twelvetrees, 1915.)

Part II.—Petrological Descriptions

By

A. H. Voisey

An examination of three rocks submitted to me by Dr. A. N. Lewis from the New Town coal field has yielded the following results:—

No. 1.—Grey Crystal Tuff

(Greenish in weathered hand specimens)

The rock is a light greenish-grey colour, marked by numerous black spots each a millimetre or two in diameter. The fracture is irregular, and the surface is easily scratched with a knife. The presence of a large quantity of calcite is demonstrated by the violent effervescence when hydrochloric acid is applied.

When examined under the microscope the rock is seen to consist of angular grains of minerals and fragments of igneous rock, all being set in a matrix of calcium carbonate in the form of calcite. Decomposition has affected all of the minerals with the exception of quartz, and the calcite, which, for the most part at least, is secondary, has replaced many of the original constituents.

The dark spots so noticeable in the hand specimen are irregular masses of chloritic material, with minute particles of iron ore, which impart a dark colour to the fragments. Some of these represent igneous rock which has been ejected from a volcano. Under the high power objective they are seen to be composed of minute felspar laths, set in a chloritic groundmass.

Quartz is the most common mineral, and is in the form of irregular grains, generally about ·25 mm. in diameter. Some of the grains are wedge-shaped, and others have concave sides which suggest a volcanic origin. None of them show any signs of wear through transport by water.

Plagioclase felspar is present in small quantities, but is extensively decomposed, and it is probable that calcite has replaced much of the felspar which was originally present. One grain showing carlsbad and albite twinning occurs, and may be andesene. Apart from the chloritic material which forms part of the included

rock fragments, the mineral chlorite is present, and has been derived from what were probably ferro-magnesian minerals originally in the rock. Small quantities of haematite and limonite are to be seen.

By far the most common constituent of the rock is calcite. All the other mineral and rock fragments are set in it, while the outline of certain grains suggests the replacement of other minerals. Such replacement is not an uncommon feature of tuffs, as they are usually porous and particularly liable to alteration by solutions. Some of the calcite is in the form of radiating fibrous aggregates, which give rather striking extinction effects when seen between crossed nicols.

The chemical composition of the fresh rock is in doubt owing to decomposition. It appears to be best described as a crystal tuff with basic affinities.

No. 2.—Grey Crystal Tuff

(Yellowish in weathered hand specimens)

The rock is grey in colour, turning to a buff owing to decomposition. It differs from No. 1 in that the characteristic dark spots are absent. It is calcareous, and effervesces strongly with hydrochloric acid.

Under the microscope angular wedge-shaped and triangular quartz grains, ragged chlorite, plagioclase felspar, and occasional rock fragments were detected. All these are set in a matrix of calcite.

Plagioclase is more abundant than in No. 1, but it is still subordinate to quartz. It is being replaced by calcite, but otherwise does not show a great deal of decomposition. Albite twinning is well displayed, and the high extinction angle of 32 degrees denotes the presence of the basic variety of felspar, labradorite. The grains are generally ·25 mm. in diameter.

Any ferro-magnesian minerals which were in the rock have been decomposed, yielding chlorite. A few fragments of haematite and limonite are present.

The inclusions of igneous rock are of interest. Most of them are lighter in colour than those in No. 1, and are less than half a millimetre in diameter. Under the high power objective some are seen to possess trachytic fabric, and to consist of minute felspar laths with interstitial chloritic material. The felspars are too small to permit accurate identification.

Several small rock fragments showing a mosaic of quartz and felspar between crossed nicols appear to be pieces of metamorphosed sedimentary rock, probably torn off the walls of the vent as the volcanic material burst through.

Calcite, mainly in the form of fibrous aggregates, makes up the remainder of the rock. The presence of labradorite denotes a basic rock, but the basicity is off-set somewhat by the quantity of quartz.

The rock is a decomposed crystal tuff with basic affinities.

No. 3.—Grey Crystal Tuff

This rock is light-grey in colour, and is characterized by the presence of thin bands of black carbonaceous material, which represents plant remains. It effervesces strongly with acid, and closely resembles rocks Nos. 1 and 2.

When examined in thin section it is seen to contain more quartz grains and fewer rock fragments than the other two rocks. Plagioclase is comparable in amount to No. 2, and is either andesene or labradorite. Chlorite and iron oxides are present in the usual quantities.

The carbonaceous material is black, and is closely associated with fibrous masses of calcite. Plant cells, probably the remains of secondary wood of a gymnospern, are seen.

Calcite, as usual, comprises the bulk of the rock. It has a fibrous spherulitic structure in part, and has replaced a large proportion of the other original constituents.

The rock is a crystal tuff of intermediate composition.

General Remarks

The tuffaceous character of the rocks submitted is sufficiently proven by the nature and shape of the various constituents. Especially noteworthy is the presence of small fragments of rock, presumably thrown out by the volcano. The curved faces and wedge-like shape of many quartz grains constitute supporting evidence.

The presence of so much calcite is a notable feature of the rocks, but most, is not all, of it must be regarded as secondary. The original tuffs were probably far more felspathic than the specimens examined, and it is on this assumption, following the identification of some basic felspar, that the writer suggests they have basic tendencies.

It is not possible for the writer to state definitely the nature of the magma from which the tuffs were derived.

Part III.—Significance of the Discovery

By

A. N. Lewis

(With suggestions by A. H. Voisey)

The mere record of tuffs from the Tasmanian coal measures is of itself sufficiently important to warrant notice. In future, attention should be directed to an endeavour to identify further occurrences. A useful correlation may be possible by this means. It will also be interesting to observe whether this igneous material is at all widely distributed throughout Tasmania.

Beyond this, however, we have here a definite record of volcanic activity during a time when none was previously suspected. The Tasmanian coal measures are included in a group of felspathic sandstones. It is difficult to see what rock would yield predominate felspar grains, since this mineral usually weathers out first, and breaks up first under the mechanical effects of transportation. It is possible that our felspathic sandstones are the result of the resorting by water of ash and other volcanic material erupted contemporaneously with the deposition of the coal measures.

No indication is yet forthcoming of the location of the volcano responsible for these tuffs. The absence of signs of wear due to transportation indicates a reasonably close proximity. The whole circumstance indicates the existence of a geography at the time very different from a continuous coal swamp. No igneous plugs or vents of an age absolutely contemporaneous with the formation of the coal measures have yet been identified, but it is possible that occurrences hitherto generally assigned to the later intrusions of dolerite may be associated with this phase of volcanic activity. The possibility of islands of permian mudstone amongst the coal swamps should also be borne in mind. No solution of the new problems thus opened up by the discovery can yet be offered, but they are mentioned as a guide for future observations.

The most important fact for future investigation is the relationship, if any, of these tuffs to the later dolerite intrusions. As Mr. Voisey has indicated, the specimens examined give us no clue as to the origin of the magma. Tuffs of highly doubtful origin occur in various places in Eastern Australia in rocks from Permian to Jurassic age. However, it has long been my opinion that the dolerite intrusions close the epoch of fresh-water deposition—that is, they should be assigned an age either late Triassic or very early Jurassic, and also that some igneous material must have found its way to the surface, although this has probably all been eroded away long since. I am also of the opinion that there were several phases of dolerite intrusions, giving rocks of slightly different chemical and physical properties. The dolerite was an undifferentiated basic magma of enormous bulk. It is not impossible that such an igneous phase would be preceded by an eruptive volcanic stage yielding a more acid rock, and that these tuffs are therefore the result of the opening phase of intense igneous acvitity, which later gave us our dolerite masses and associated structural deformation. Definite conclusions on these lines of thought must, however, await further field evidence.

References

THUREAU, G., 1883.—The Carboniferous Deposits near New Town. *Journ. and Papers, House of Assembly*, 1883, *Session II., No.* 3.

KRAUSE, F. M., 1884.—The New Town Carboniferous Deposits. *Journ. and Papers, House of Assembly*, 1883, *Session II., No.* 3.

JOHNSTON, R. M., 1886.—Fresh Contributions to Our Knowledge of the Plants of Mesozoic Age in Tasmania. *Pap. and Proc. Roy. Soc. Tasm.*, 1886. p. 160.

————————, 1888.—*Geology of Tasmania.* p. 175.

GEOLOGICAL SURVEY, 1922.—The Coal Resources of Tasmania. *Mineral Resources Paper No.* 7. Chap. VIII.

TWELVETREES, W. H., 1915.—Reconnaissance of Country Between Recherche Bay and New River. *Geo. Sur. Tas. Bull.* 24. p. 5.

WALKOM, A. B., 1926.—Notes on Some Tasmanian Mesozoic Plants, Part II. *Pap. and Proc. Roy. Soc. Tasm.*, 1925. p. 63.

PLATE IV.—EXPLANATIONS OF MICROPHOTOGRAPHS.

FIG. No. 1.—Magnification 33/1. The large black patch is a fragment of volcanic rock, black being chlorite, and the lath-shaped crystals felspar. The white quartz grains are irregular in shape. Most of the grey background is calcite.

FIG. No. 2.—Magnification 33/1. The irregular outlines of white quartz grains are noteworthy. Black areas represent chlorite, and the grey speckled groundmass is calcite.

FIG. No. 3.—Magnification 77/1. Peculiar extinction effects in fibrous aggregates of calcite. Black patches are mainly calcite.

FIG. 1

FIG. 2

FIG. 3

The Male Meiotic Cycle in the Genus *Eucalyptus*

By

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Physics Department, University of Tasmania

(Read 8th November, 1937)

Plates V-VI

This investigation was undertaken originally to determine the chromosome number of various eucalypts. Observations of the course of meiosis have been made in the pollen mother cells of eight species, and, as no work seems to have been carried out on meiosis in *Eucalyptus* previously, it seemed desirable to place the main results of the investigation on record in view of the important place which the genus occupies in our flora. The account of the meiotic cycle given should be reasonably typical of the process in Tasmanian forms at least.

Material and Technique

The collection of buds at the appropriate stage of development was made usually on a clear sunny day between noon and 4 p.m. The anthers were squeezed from the young buds into a tube containing fixative, which was then partially exhausted with a vacuum pump, in order to remove air from the tissues, and so ensure rapid fixation. The small size of the buds in some species made this process long and tedious.

The fixatives employed were (*a*) an alcohol, acetic acid, ferric hydrate mixture, (*b*) Navashin's modification of Karpechenko's fluid, and (*c*) Helly's liquid, a mercury bichloride fixative used as a check against artifacts which might be due to acetic acid fixation.

The first fixative was used in all preliminary work, for which it was admirably suited, as the light, slightly waxy anthers sank in it immediately, and were rapidly fixed. After fixation for two or three hours the anthers were washed in absolute alcohol, and were then ready for clearing and paraffin infiltration. Despite the apparently drastic nature of this fixative, the resulting preparations were

remarkably good, and compared very favourably with material fixed in Navashin and Helly. These latter fixatives were relied on for all fine detail in the cytological structures.

Sections about 20 μ in thickness were cut by the paraffin method, and stained in gentian violet, haematoxylin, or sulphurous fuchsine (Feulgen). Photographic records have been made extensively during the investigation, as it is considered that the camera provides the best means of illustration, whenever it is applicable.

Chromosome Number

The chromosome number has been determined for *E. globulus*[1], *E. Johnstoni*[1], *E. linearis*, *E. pauciflora*, *E. viminalis*, *E. obliqua*, *E. salicifolia*, and *E. cordata*, which are fairly representative of the main types of Tasmanian eucalypts. In each of these species the haploid number has been found to be eleven.

The stage best suited to the purpose of counting the chromosomes is that of late diakinesis, which is particularly conspicuous in most of the material examined. The chromosomes at this juncture are compact, well-separated bodies dispersed throughout the nucleus (Plate V, figs. 1 and 2). This has been used as a standard stage for counting. In metaphase I and anaphase I the chromosomes are smaller and more closely crowded, often showing a tendency to clump, an appearance doubtless exaggerated by fixation. Many well-figured plates have been examined nevertheless, and photographs of some are appended. The counts have, of course, been confirmed at practically every subsequent stage. For example, the telophase II nuclei shown in Plate VI, figures 6-7, are from an anther in which it was possible to make many unambiguous counts, in spite of the fact that this stage is particularly difficult. Prophase II (Plate VI, fig. 3) includes one phase in which good counts can be made.

The Meiotic Cycle

The course of meiosis is of the type associated with a vesicular[2] nucleus. The second prophase appears to follow an unusual course. A detailed account of those phases which appear quite normal will not be given, but typical photographs are shown. The prophase I stages from leptotene to diplotene have not been examined in great detail, but there is nothing to suggest deviation from the normal here. It is hoped to examine the chromosome figures and chiasmata at some later time.

Metaphase I chromosomes appear as spheroidal bodies, and this, together with early anaphase figures, suggests complete terminalization of chiasmata. In metaphase I and anaphase I plates in *E. globulus* there is evidence of secondary pairing (Plate V, fig. 3, and

[1] See References (p. 44). [2] See References (p. 44).

cf. fig. 6). Owing to variability in the metaphase arrangements which have been observed, nothing further can be said about the pairing tendency yet, but there are many cells exhibiting chromosome patterns which make the conclusion difficult to resist.

The most interesting feature of the meiotic cycle is a very characteristic appearance which occurs during prophase II (Plate VI, figs. 2-3). In this, the chromosomes appear as well-figured bivalents, distributed in each nucleus over that half of the nuclear boundary which is nearest to the centre of the cell. When viewed from the poles of the cell they are seen to exhibit two saucer-like distributions, whose convex surfaces are towards each other.

The course of the cycle from anaphase I to metaphase II is briefly as follows:—

The formation of an interphase nucleus from the anaphase I plate commences with the appearance of nuclear sap, and hence the delimination of a nuclear boundary, accompanied by the movement of the chromosomes out towards this boundary. The amount of chromatin in the chromosomes decreases, and a single nucleolus is formed. The organization of the interphase nucleus is carried out very completely, particularly in *E. obliqua* (Plate V, fig. 8).

In early prophase II the chromosomes reappear, being distributed throughout the nucleus, which, by this time, has increased considerably in diameter (Plate V, fig. 9; Plate VI, fig. 1). The form of the chromosomes is difficult to ascertain here, but becomes clearer as the prophase continues. The later stages are characterized by a movement of the chromosomes in each nucleus towards the sister nucleus, culminating in their arrangement on the nuclear boundaries as two saucer-shaped distributions, the convex faces being towards each other. These are seen in lateral view in Plate VI, fig. 2, and in polar view in fig. 3. The two chromatids of each bivalent are attached to each other near their centres, presumably the region of the centromere, their distal parts being generally widely separated. The nucleolus has disapeared by this time, although occasional cells were found in which it had persisted to this stage (Plate VI, fig. 4. cell A).

Following this, the chromosomes condense into a compact form, the mutual repulsion of the chromatids in each bivalent having ceased apparently, while the nuclear-cytoplasmic interface disappears, and the chromosomes pass to their metaphase positions on the two spindles. The cell would appear to be in an unstable state at the time of the disappearance of the nuclear boundary, as then there is a marked tendency for the chromosomes to become aggregated. Fixation apparently causes a collapse of the matrix in which they are distributed. Judging from the infrequency of the occurrence of clearly defined chromosomes on plates in metaphase II, this phase must be passed through very rapidly.

Anaphase II and telophase II are quite normal.

We desire to express our thanks to the Trustees of the Science and Industry Endowment Fund for their generous aid which made the investigation possible in the first place. Its later phases have been assisted by the Commonwealth research grants to the universities. Our thanks are also due to the State Forestry Department, and to Mr. Rafferty of that Department, for assistance in the field.

References

[1] McAulay, A. L., Cruickshank, F. D., and Brett, R. G., 1936.—*Nature*, 138; 550.
[2] Manton, T., 1935.—*Proc. Roy. Soc., Series B*, Vol. 118; 522.

PLATE V

Fig. 1.—Cells of *E. obliqua* in diakinesis. In one cell eleven tetrads are just discernible. A nucleolus is present. × 900. Helly, gentian violet.

Fig. 2.—Cell of *E. Johnstoni* in late diakinesis. The nucleolus has disappeared. The photograph was made in two exposures superimposed on the same negative. × 1000. Alcohol-acetic, gentian violet.

Fig. 3.—Metaphase I. in *E. globulus*. Note evidence of secondary pairing and cf. fig. 6. × 2000. Helly, gentian violet.

Fig. 4.—Metaphase I. in *E. Johnstoni*. × 2000. Alcohol-acetic, gentian violet.

Fig. 5.—Early anaphase I. in *E. globulus*. × 2000. Helly, gentian violet.

Fig. 6.—Anaphase I. *E. globulus*. × 2000. Helly, gentian violet.

Fig. 7.—Late anaphase I. *E. globulus*. × 2000. Helly, gentian violet.

Fig. 8.—Late telophase I. *E. obliqua*. × 2000. Helly, gentian violet.

Fig. 9.—Early stage in prophase II. in *E. obliqua*. × 2000. Helly, gentian violet.

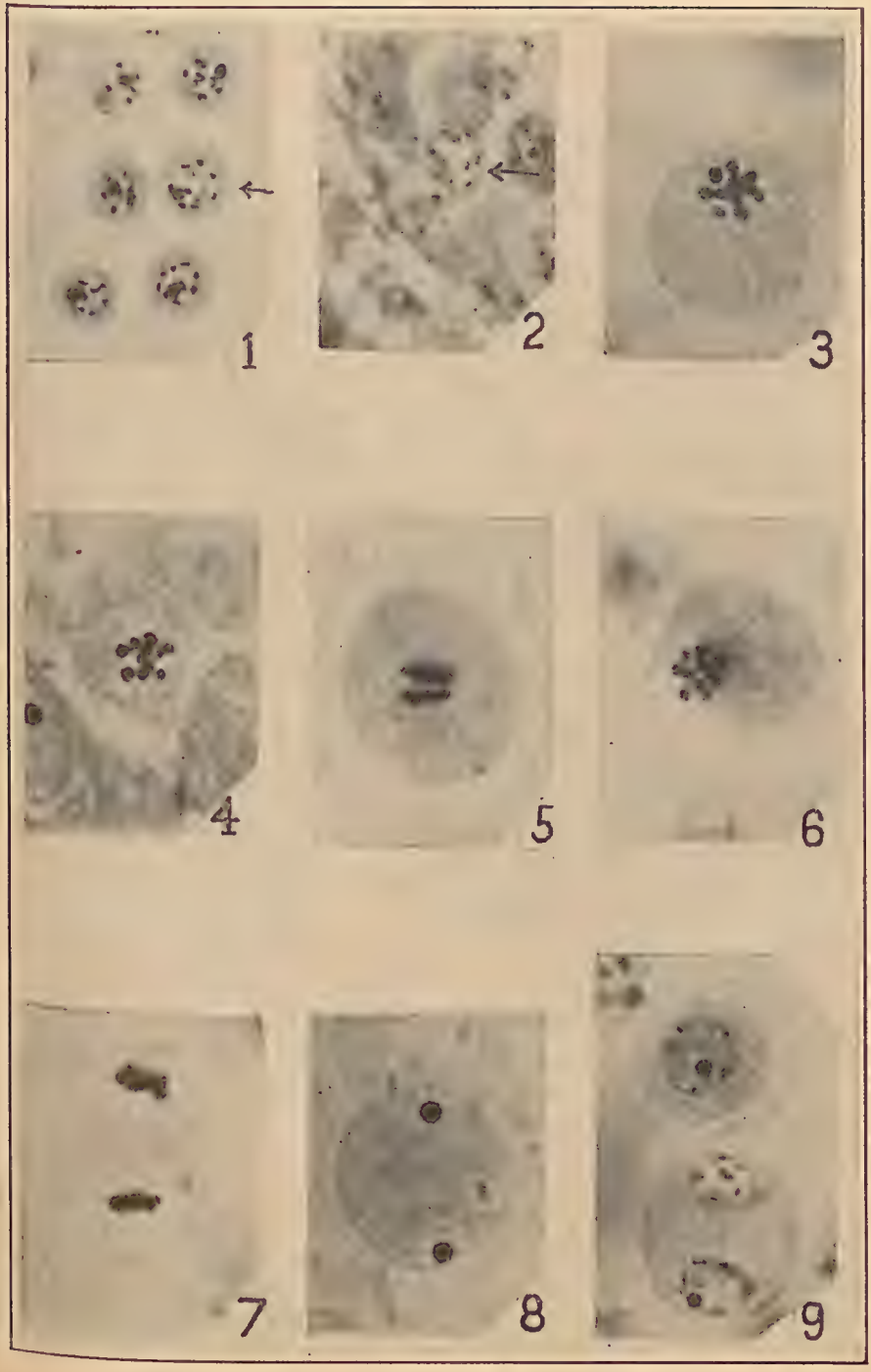
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PLATE VI

FIG. 1.—Later stage in prophase II. *E. obliqua.* × 2000. Helly, gentian violet.

FIG. 2.—Prophase II. *E. globulus.* 'Saucer' stage in lateral view. × 2000. Helly, gentian violet.

FIG. 3.—Prophase II. *E. globulus.* 'Saucer' stage seen from above, showing structure of bivalents. × 2500. Helly, gentian violet.

FIG. 4.—Cells of *E. globulus* in various stages of prophase II. Cell 'A' has almost reached the 'saucer' stage, nucleoli still present; cell 'B' is that shown in fig. 2; cell 'C' shows an oblique view of the 'saucer' stage, both nuclei being visible because of low magnification; cell 'D' shows chromosomes clumped approaching metaphase II. × 900.

FIG. 5.—Metaphase II. *E. globulus.* × 900. Helly, gentian violet.

FIG. 6.—Cell in telophase II. in *E. obliqua.* × 2000. Helly, gentian violet.

FIG. 7.—The fourth nucleus of the cell shown in fig. 6. Eight chromosomes are shown on the periphery; the other three, one of which is just visible, are arranged close to the nucleolus. × 2000.

FIG. 8.—Later stage in telophase II. *E. globulus.* × 2000. Helly, gentian violet.

FIG. 9.—Completion of telophase, showing daughter cells fully formed within wall of parent cell. *E. globulus.* × 2000.

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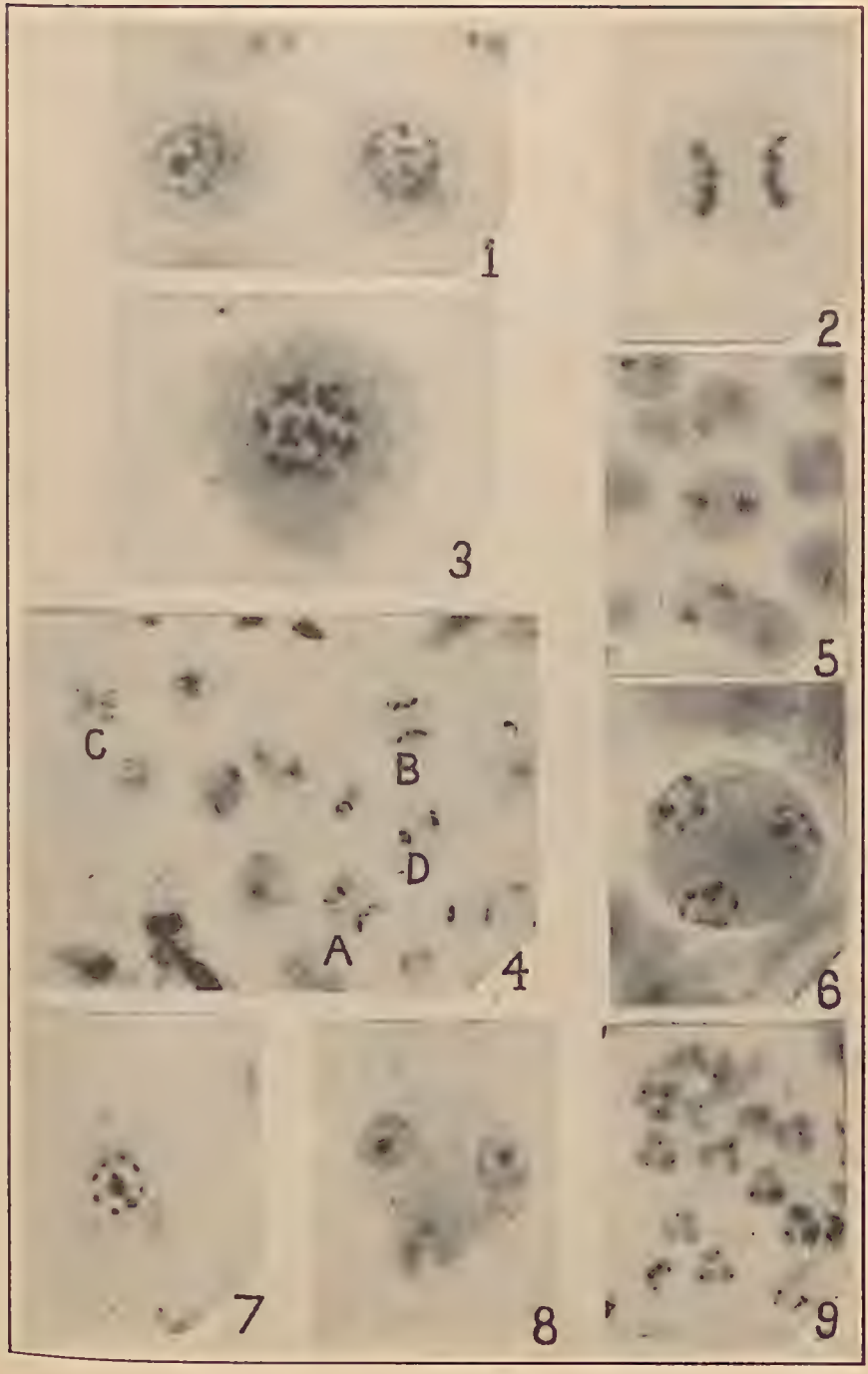
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Pap. & Proc. Roy. Soc. Tasmania, 1937 (20th May, 1938)

Evidence for the Existence of a Natural Hybrid between *Eucalyptus globulus* and *Eucalyptus ovata*

By

A. L. McAulay, F.Inst.P.

(Read 8th November, 1937)

Plates VII-VIII

In the course of a joint investigation made at Bagdad by Mr. R. G. Brett and myself on suspected hybrids of *Eucalyptus globulus* and *Eucalyptus viminalis*, a tree was found by Mr. Brett which we considered to be a hybrid of *E. globulus* and *E. ovata*. After considering all other possible origins for the tree, including the possibility that it was an importation from outside Tasmania, we both reached the definite conclusion that it was a hybrid derived from the above two species.

Owing to the great dissimilarity between the young growth of *E. globulus* and *E. ovata*, this tree should provide an unusually good opportunity of testing for hybridization by raising seedlings. I have grown somewhere about fifty seedlings from it, and hope to raise ten or more to maturity.

It is considered that the result definitely confirms the theory that the tree is a hybrid, and, as at present the occurrence of natural hybrids is a controversial matter, it seems worth while to record the evidence. The seedlings range from something hardly distinguishable from *E. globulus* to something indistinguishable from *E. ovata*, through intermediate types. Plate VII, fig. I (*a*), is a photograph from a *globulus*-like seedling, fig. I (*b*) a photograph from an *ovata*-like seedling. Fig. II (*a*) is a photograph from a seedling of *E. globulus*, and fig. II (*b*) from a seedling of *E. ovata*, grown under the same conditions. These are shown for comparison. Figs. I (*a*) and (*b*) and II (*b*) are directly comparable; II (*a*) is from a rather older plant.

In Plate VII all the photographs are on the same scale. Points worth noticing are the square-sectioned thick stem and large pointed leaves on the *globulus* and *globulus*-like specimens, and the thin, markedly glandular stem and small oval leaves on the *ovata* and *ovata*-like specimens.

The resemblance of I (*a*) to II (*a*) and of I (*b*) to II (*b*), and the difference between I (*a*) and I (*b*), is not so noticeable in the photograph as in the actual plants, owing to the striking colour difference between young *E. globulus* and young *E. ovata*, which is matched in the extreme cases of the seedlings from the suggested hybrid.

Plate VIII, fig. III (*c*), shows some fruit of the suspected hybrid parent. Figs. III (*b*) and III (*a*) show fruit from *E. globulus* and *E. ovata* for comparison.

The above is a part of work done for the biological survey of Tasmania initiated by Dr. J. Pearson.

PLATE VII

FIG. I (*a*), I (*b*).—Photographs of foliage of two contrasted seedlings from the suspected hybrid.

FIG. II (*a*).—Foliage from young *E. globulus*.

FIG. II (*b*).—Foliage from young *E. ovata*.

I(a)

I(b)

II(a)

II(b)

PLATE VIII

FIG. III (*a*).—Fruit of *E. ovata*.

FIG. III (*b*).—Fruit of *E. globulus*.

FIG. III (*c*).—Fruit of suspected hybrid.

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III (a)

III (c)

III (b)

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Aboriginal Carvings Found at Trial Harbour

By

J. F. Jones

(Read 8th November, 1937)

Plates IX-X

Along the shore near the old settlement at Trial Harbour there are numerous middens of the Tasmanian aborigines. A large one is situated on the south side of the creek, and there still remain the hollows in the sandy soil over which the natives built their huts. Other middens are to be found along the seaside, both to the north and to the south.

On the northern side, about a quarter of a mile from the harbour, a large boulder of granite lies on the upper part of the beach beyond the reach of ordinary tides (Plate IX, figs. 1 and 2). In shape it resembles a broad-beamed decked boat. The top measures about ten feet by seven. It is smooth and fairly level. This rock evidently was the resort of the natives of the vicinity, who used the flat top for engraving their carvings and for other purposes. Probably it was thus used for many centuries, as the remains of incisions that have partly weathered away can be seen, in addition to those made more recently.

About a dozen rings have been made to a depth that, at present, averages about a quarter of an inch. It seems probable that, originally, this depth was greater, and has been diminished by the action of the sea and the weather. In size these rings measure from a foot in diameter to about half that width. The incisions forming the circumferences of the rings are about one and a half inches wide.

At the north end of the boulder there is a group of seven rings placed rather closely together. These are each of about seven inches in diameter. The other rings are scattered irregularly over the

surface, and are mostly of larger size, the largest being fifteen inches from edge to edge. Besides these, there are arcs of other circles, indistinctly visible, the remainder having weathered away.

In addition to these circular markings there are several smooth hollows that appear to be the work of the natives (Plate X, fig. 1). The largest of these is about seven inches long, three inches wide, and, in the middle, about one inch deep, the depth lessening regularly towards the edges all round.

This depression appears to have been produced by friction—perhaps by grinding some hard substance, such as ochre, by means of a smooth, round stone. It resembles the hollows made by the Tasmanian natives in some of their stone implements, but is larger than any of these that the writer has seen. In addition to this large hollow, there are two groups each containing several smooth hollows of smaller size and of lesser depth.

The boulder on which these carvings were made is a solid mass of very hard granite. How the natives were able to mark it to the depth mentioned is difficult to understand. The writer hoped, before the visit to Trial Harbour commenced, that by excavating round the base of the rock and sifting out the surface soil, some of the implements used in forming the rings might be discovered. Unfortunately, however, after the necessary tools had been carried to the spot, it was found that the boulder was not above water-mark during storms, and that, at such times, the waves swirled almost all round it, and must have shifted the surface material again and again. Only one portion of the surface, situated on the landward side and protected by two large rocks, had not been thus disturbed by the waves. In this space, measuring about three feet along the side of the boulder, several implements were found, but they were only flakes, and probably had nothing to do with the formation of the rings. The smooth surface of the rock must have made it a favourite resort of the natives from the neighbouring camps. Its solidity and hardness provided an excellent anvil, or table, for the manufacture of the various implements they used.

How they formed the markings in such a very hard medium is, at present, only a subject for conjecture. Repeated hammering with a hard stone on the surface of the granite makes almost no impression, while the rock rings like metal when struck. If the rings were made by cutting or scratching the surface with a harder kind of stone, the edges would probably be sharper and the ring itself narrower, as requiring less material to be removed. If, however, the rings were formed by hammering the surface with a hard and heavy stone, they would be wide and shallow, as they are.

Their purpose can only be guessed. It is well known that it is customary among peoples like the Tasmanian aborigines to depict by drawings, paintings, or carvings, objects upon which they are

dependent for their welfare, in the belief that such representations of these objects will increase or favourably influence their production. Some of the carvings found at the Bluff, Devonport, by Mr. A. L. Meston undoubtedly represent the haliotis, a shell-fish that formed an important part of the food supply of the natives living near the shore. The numerous circles found near Mt. Cameron West and at Trial Harbour do not appear to represent an article of food. A large ring found at the former place was surrounded by numbers of small markings cut into the rock. Do these rings represent the heavenly bodies? By a naked savage, dwelling on the exposed West Coast, where bitter winds from the south-west are common even in the summer months, the sun must have been regarded as a beneficent influence that might be induced, by means of the representations on the face of the rock, to come forth from the heavy clouds which so often obscured its kindly rays.

Or perhaps the rings, surrounded by the smaller markings, may have represented the moon and stars, which, to natives spending almost all their lives in the open, must have been objects of great interest. George A. Robinson and others who were in close touch with the aborigines in their wild state reported that they feared the moon, and would not travel at night. It may be that a desire to placate it and to diminish its evil influence was the motive that induced them to undertake the heavy labour of inscribing these circles.

In relation to the formation of such circular objects in stone by the Tasmanian natives, the writer desires to draw attention to another activity of the West Coast tribes that may have had a somewhat similar purpose to that suggested above. These natives, especially those living in the north-west corner of the island, were in the habit of shaping stones into a circular form. They did this sometimes with remarkable accuracy, the circular edges being as true as though produced by a lathe (Plate X, fig. 2). Their method of working was peculiar, and was nearly always the same. They selected a smooth, waterworn stone of oval shape, commonly of white quartzite, though other varieties were sometimes used. This stone was used for hammering, or, perhaps, was hammered to reduce its length. It was held so that blows were struck only with, or on, the ends. Many specimens can be found with both ends flattened and worn away, but without any scar from a blow appearing on any other portion of the stone, which, except at the ends, retains the waterworn smoothness that it had at first. By continued hammering, these ends were, in time, so worn away that the long axis of the stone became reduced to the same length as the shorter one. When this was accomplished, the natives began to hammer, not only with the ends, but with the edge, gradually producing a circular form flattened all round its circumference,

and, but for the curved faces, resembling the casters of an arm-chair or sofa. It is interesting to note that, though so much hammering was done in reducing the length and in forming the circular edge, the two faces do not show the scar of a single blow, but remain smooth and unhammered.

These stones appear to have always been formed in the same manner, and may be found in all stages of development in the middens between Cape Grim and the Pieman River. They are commonest about Mt. Cameron West, Marrawah, and Bluff Point. Their weight is usually about three ounces, but many perfectly formed specimens weigh one ounce, while a few are little more than a half-ounce in weight. Some, however, are much larger, and weigh as much as two pounds, but the large ones are seldom as well formed as the lighter ones.

A very interesting fact in connection with this matter is that stones of precisely similar formation, size, and material, and apparently of precisely similar workmanship, have been found buried under limestone floors in Kent's Cavern, near Torquay, England. These can be seen in the British Museum, and date back to a very remote period indeed.

The very diminutive size and weight of some of the smallest Tasmanian hammer stones seems to preclude the notion that they were formed for hammering, and leaves their actual purpose a mystery.

In concluding this article the writer desires to point out that, on the West Coast of Tasmania, there are, at present, numerous evidences that the aborigines in this district had permanent dwellings, or, at any rate, occupied the same camps for considerable periods. Several sites of their camps, showing the positions of two to six or eight huts, are still to be seen, though the movements of hundreds of head of cattle, which are turned out each year to graze over the area, are producing sand-blows and causing the destruction of many of the sites.

If a model were made from accurate measurements of one or two of the larger sites, showing the kind of position the natives selected, it would probably be of great interest in years to come, when the originals will have disappeared.

In his 'Journal of Discoveries in Van Diemen's Land' (1827) Jorgensen makes frequent mention of the superior quality of the huts of the natives along the West Coast. In one entry he says: 'The huts, as well as baskets and other things produced by the Western natives, evince great ingenuity, and the nature of the country compels them to build compact dwellings to shelter them against the bleak winds blowing over a large tract of open country, not well supplied with fuel and of a piercing chilliness'. In another

place he says that Native Hut River ' is so called from a peaceable tribe of natives who reside in good huts hereabouts '.

Again he says: ' On our way to Venable's Boat Harbour we observed a very compact native hut, far different (as are all huts in this quarter) from those seen to the Eastward. It was a complete piece of Gothic Architecture, in the shape of a dome, and presenting all the first rudiments of that Science. It was made to contain 12 to 14 persons with ease. The entrance was small and not above two feet high. The wood used for the principal supports had been steamed and bent by fire '.

While there is still opportunity, it is very desirable that the valuable and interesting information concerning the West Coast natives that is still available should be collected, and that our knowledge of their lives and customs shall be extended before it is too late.

PLATE IX

FIG. 1.—Granite boulder at Trial Harbour, bearing aboriginal rock carvings.
FIG. 2.—Another view of the same.

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Fig. 1.

Fig. 2

PLATE X

FIG. 1.—Worked hollows.
FIG. 2.—Completed hammer stones.

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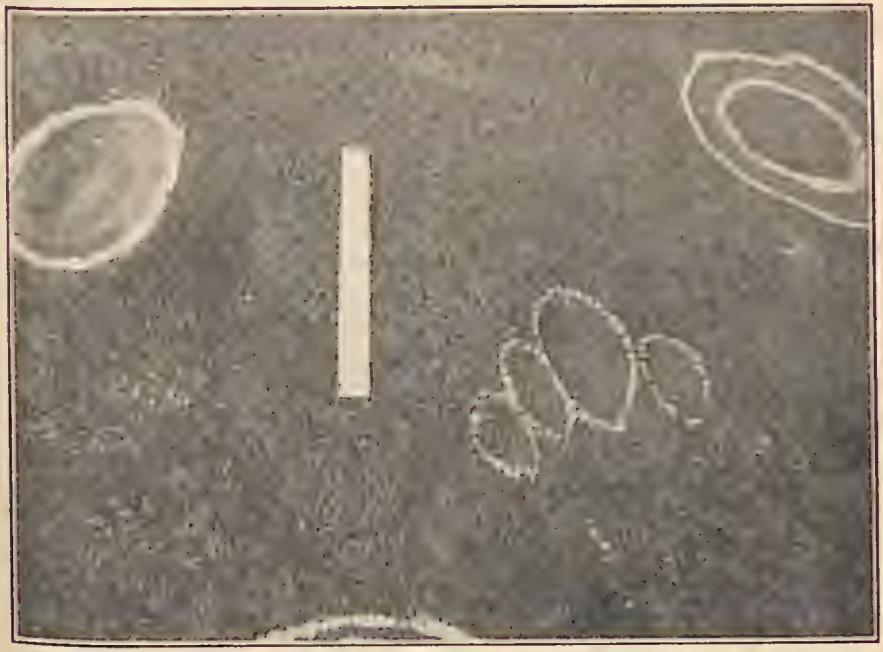

Fig. 1.

Fig. 2.

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D'Entrecasteaux: An Account of His Life, His Expedition, and His Officers

By

G. H. Hogg

(Read 12th April, 1937)

Plates XI-XIV; and 1 Text-figure

In November, 1737, two hundred years ago, at the Chateau D'Entrecasteaux, near Aix-en-Provence, Antoine Raymond Joseph de Bruni, Chevalier d'Entrecasteaux, was born. His father, the Marquis d'Entrecasteaux, was for a time President of the Parliament of Provence.

Educated at the Jesuit colleges of Aix and of Paris, he entered the navy in 1745 as a cadet, under the patronage of his relative, the great Suffren, took an active part in the Seven Years' War, and so distinguished himself in the battle of Minorca, where the English fleet, under Admiral Byng, was defeated, that he was given the grade of sub-lieutenant; serving later on the 'Hirondelle', he was noted for his skill in hydrographic work. In 1769, when Corsica was taken, he was given the command of a small boat—the 'Espion'—and in 1770 was promoted to the rank of lieutenant. Decorated with the Croix de Saint Louis in 1775, he sailed under Suffren until 1778, when he commanded a frigate in the Levant against the pirates who at that time menaced the trade routes. Captain in 1779, he commanded the 'Majesteaux', a vessel of 110 guns, and later the 'Puissant'. The extent of his knowledge, the integrity of his character, and the clearness of his judgment attracted the attention of the Marechal de Castries, Minister for Marine, who appointed him Assistant-Director of Ports and Arsenals under M. de Fleurieu.

In 1785, as commodore, he took over the command of the Indian station, where he displayed the French flag from the Red to the China seas; indeed, this was the first time that it had been seen in Chinese waters, the intention being to show the Emperor how it must be treated with proper respect.

His dispatches show how he boldly pointed out the faults of French colonial administration and the means of remedying them, how he foreshadowed French Indo-China, how he realized the value of Eastern trade, and warned his Government how British policy threatened French interests in the Far East. In addition to this political work, by studying the effects of currents and winds, by carrying out surveys, and by correcting the faulty charts of the English and Dutch sailors who had preceded him, D'Entrecasteaux made navigation in these Eastern waters much safer. At Pondichéry orders reached him to repair to the Ile de France, where, as Governor-General, he was to take over the administration of the Ile de France and Bourbon (Mauritius and Reunion) and the command of all the forces, both naval and military. He found the affairs of these colonies in great disorder, and it is interesting to note how the sailor transported from the deck of his flagship to the vice-regal residency took up the role of legislator and administrator. Currency, exchange, commerce, industry, and agriculture were dealt with in a systematic manner. In relation to agriculture, one of the troubles with which he had to deal was the same as that which developed in our own Australian states, land-hunger, the desire of the colonists to acquire additional land grants from the Crown whilst failing even to clear and develop estates already in their possession. These islands, commanding as they did the entrance to the Indian seas, were regarded by D'Entrecasteaux as of great strategic value for a naval base, where not only ships of war and merchantmen could be refitted and victualled, but whence expeditions could be sent all over Asia. He found the docks and arsenal in great disorder and the shipping in very bad repair, and he at once urged the Home Government to bring the defences up to date. 'So long', he said, 'as Holland is the rival of Great Britain there is no fear of any attack, but from the day that there is a rapprochement between the two powers, the English may attempt the capture of these colonies'.

D'Entrecasteaux also envisaged the importance of Madagascar and other islands in relation to Great Britain, and considered the question of taking possession of it more than a hundred years before its occupation by the French Republic.

Military matters gave no little trouble. There was jealousy and ill-feeling between the French troops and the Irish regiment of Walsh which took all the tact of the governor to calm. The militia question was a source of further trouble, while the general body of the colonists was answerable for many disturbances; the cause of these was the colour question, which threatened a civil war, especially at the time of the mobilization of the militia. This he thoroughly reorganized, and at the same time put the general defences of the colony into a better condition.

The son of an old Catholic family, educated by Jesuit fathers, D'Entrecasteaux, although he escaped the scepticism of his age, never showed any trace of bigotry. Tolerant and liberal in his ideas, he disapproved of any narrowness or bitterness on the part of the clergy, and expressed himself strongly against their action in the case of mixed marriages.

A good number of Dutch colonists had settled in the colony, and there were prospects of further Dutch and English emigration, which the Governor-General wished to encourage. Certain regulations had been made by the church dealing with this question. 'Your measures', he said to them, 'to prevent the propagation of error are precisely those which have been made use of to oppose the establishment and progress of Christianity; they are purely human methods, which a politician might employ, but which are forbidden by the Gospels, and should never have been entertained by ministers of the true religion'.

Health reasons and family affairs influenced D'Entrecasteaux to resign his office, and arriving back in Brest in February, 1790, after three months' shore leave, he was given command of the 'Patriote'. By this time the revolutionary fervour was affecting the whole country. In September, 1790, Brest was in a state of excitement and almost of revolt; the King's officers were being denounced as traitors to their country, mutiny broke out in some ships, seditious sailors boarded the ships inciting the crews to revolt, and Huon de Kermadec and other officers were insulted.

In France, notwithstanding the storm and stress of the revolutionary times, great interest had been shown in the voyages of exploration to the Southern seas undertaken by Marion du Fresne and Cook. The mission of La Perouse especially had attracted attention, not in France alone, but in England, which had contributed to his expedition by supplying him with the nautical instruments of the illustrious Cook; an attention which became changed into keen concern when year after year passed without news of the 'Astrolabe' and 'Boussole', the ships in which La Perouse had sailed from Brest in 1785.

Some two years afterwards he had called at Botany Bay, just then founded by Commodore Phillip, but after quitting that port had never more been heard of. It was therefore but an expression of the nation's sympathy and concern when the National Assembly in 1791 passed a decree praying the King to dispatch an expedition in search of La Perouse and his companions. In this decree, as well as in the royal instructions, the objects of the expedition were clearly defined, namely, to search for La Perouse, and at the same time to make all possible exploration that might be useful and beneficial to navigation, to commerce, and to science. The following are extracts from the decree of the National Assembly dated February 7th, 1791: 'Decreed besides that the King be prayed to arm one or

more ships, in which shall be embarked savants, naturalists, and draughtsmen; the commanders of the expedition to be given the dual mission of searching for M. de La Perouse and of making at the same time researches relative to science and commerce'. The extracts from the royal instruction read: 'He will study the climate and the productions of the countries which he visits; he will seek to inform himself as to the customs, morals, religions, and forms of government of the natives, their method of making war, their arms, &c.

Relative to these and other documents bearing on the expedition, it is interesting to note how strange an epitome of those troubled years of French history is written therein. The commander and officers holding their commissions from Louis XVI, the expedition, formed by a decree of the National Assembly, returning to a Republic, had the journals and dispatches printed by the command of, and dedicated to, Napoleon, Emperor of the French, King of Italy, Protector of the Confederation of the Rhine. Doubtless it was in part these years of revolutionary turmoil, of internal strife, followed by those of military glory and European conquest, which drew the attention of France away from southern latitudes, checked her ideas of colonization, and allowed England to occupy the Australian continent and the adjoining island of Tasmania.

The expedition, which had been fitted out at Brest under the superintendence of D'Entrecasteaux's friend, Huon de Kermadec, consisted of two ships, the 'Recherche' and the 'Espérance', each of 500 tons, with a crew of 92 men, and armed with six 8-pound cannon and two 20-pound carronades. The 'Recherche' was commanded by D'Entrecasteaux in person, the 'Espérance' by De Kermadec.

On September 29th, 1791, the ships sailed from Brest, and by the 30th were on the high seas, when, according to orders, D'Entrecasteaux broke the seal of his dispatches, and found that he had been made rear-admiral, while two of his officers, De Kermadec and D'Auribeau, were appointed post-captains; the new admiral accordingly read his commission and hoisted his fleg, which was honoured with the usual salute.

As soon as the ships were at sea a regime, which had been carefully thought out by D'Entrecasteaux for the preservation of the health of the crews, was brought into play. The ships were cleaned, aired, and fumigated every day, and the crews were divided into three watches, so as to give each man eight hours' uninterrupted sleep; moreover, strict supervision was kept on all sailors, who were compelled, if wet after a watch, to change their clothes.

These precautions were carried out partly on the recommendation of Captain Cook, whose crew had suffered severely from disease on his first and second voyages. On October 12th Teneriffe was sighted, and on the 13th the ships anchored and took in supplies, the naturalists of the party availing themselves of the opportunity to climb the

famous peak and make collections of the flora and fauna of the island. Weighing anchor on the 23rd of October, the ships, as they made south, experienced frequent storms, stifling heat, and heavy rains; they crossed the line on November 28th, and entered Table Bay on January 17th. Next day salutes were exchanged with the fort, and the admiral landed, being formally received at Government House by the Administrator, M. Rhenius, and the Council of Regency.

The Abbé Bertrand (the astronomer), Blavier (the naturalist), and Ely (the artist) were left behind on account of ill-health; the Abbé had a narrow escape from death, falling from a precipice on Table Mountain while engaged in taking observations. Rossel, who had studied at the Paris observatory, took over the astronomical part of the work, assisted by Willaumez and De Bonvouloir.

While at the Cape D'Entrecasteaux received dispatches from the commander of the Indian station, reporting that the captains of two French ships had informed him that Commodore Hunter had seen traces near the Admiralty Islands of what might have been the remains of the uniforms of La Perouse's wrecked expedition. Commodore Hunter, on learning of these rumours, had contradicted them, the misunderstanding having been caused apparently by language difficulties. Although the admiral placed but little reliance on these reports, he considered it his duty to investigate their truth, and to change his route. Sailing from the Cape on February 16th, with the intention of passing through the Mozambique Channel, and then steering a direct course to the Admiralty Islands by the north of New Guinea, he was compelled to change his plans, as he found his ships such poor sailers that he would miss the favourable monsoons. D'Entrecasteaux decided, therefore, to sail to the south of Australia, and then make his way north to the Admiralty Islands. On March 28th the frigates sighted New Amsterdam, the exact position of which they determined; the island was surrounded by thick smoke anl enveloped in fire.

In the days which followed the ships encountered heavy gales, and were considerably strained, the 'Recherche' especially suffering from the heavy seas which she shipped, so that no attempt was made to investigate the south-west coast of New-Holland.

On April 21st land was sighted (the Mewstone) at half-past 9 in the morning, it being the intention of the admiral to anchor in Adventure Bay in order to obtain a supply of fresh water, as well as suitable wood with which to repair his battered vessels. Some mistake, however, was made by the navigating officer, and the expedition sailed into South-West Passage, anchoring for the night in a sheltered position. Although a boat had been dispatched at once to reconnoitre, it was too late to see much, but early next morning the same officers—De Saint Aignan from the 'Recherche' and De La Seinie from the 'Espérance'—left on a survey of the port, which

occupied them for two days. De Saint Aignan reported that he had found 'a large harbour surrounded by highlands and sheltered from all the winds, the sea like glass, neither shoal nor rock to be seen', that there was an abundant supply of fresh water, and that he had noticed several deserted aboriginal huts.

Acting on these reports, D'Entrecasteaux determined to sail in, but a head wind prevented him; so next day, in the early morning of April 23rd, before the breeze had sprung up, the two ships were towed by their boats to an anchorage in what was to be known henceforth as Recherche Bay.

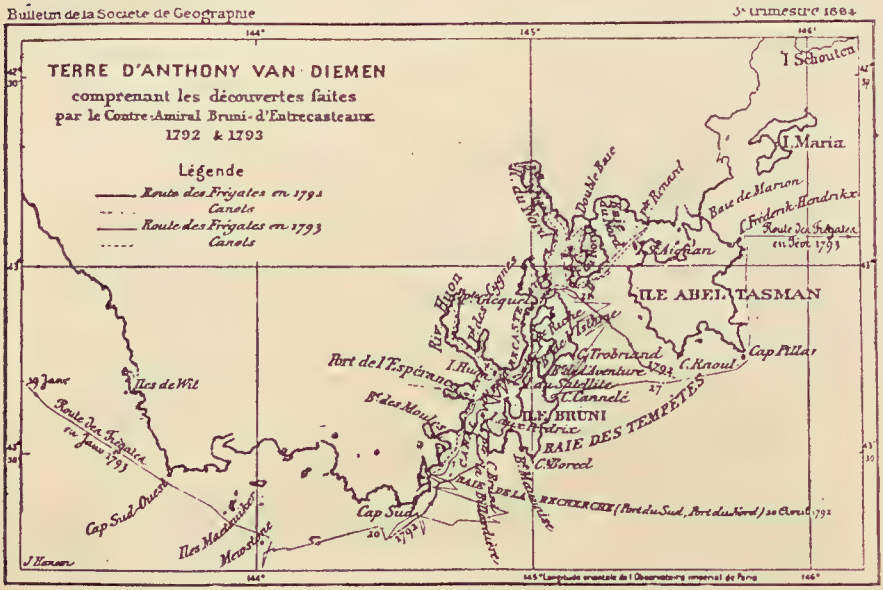

Fig. 1.

Let me quote the admiral's own words when he saw this land for the first time:

> 'It would be vain for me to attempt to describe my feelings when I beheld this lonely harbour lying at the world's end, separated as it were from the rest of the universe—'twas nature, and nature in her wildest mood. At each step we met here the beauties of that nature abandoned to herself, there the marks of her decay, trees of an immense height and proportionate diameter, their branchless trunks covered with evergreen foliage, some looking as old as the world; closely interlacing in an almost impenetrable forest, they served to support others which, crumbling with age, fertilized the soil with their debris; nature in all her vigour, and yet in a state of decay, seems

to offer to the imagination something more picturesque and more imposing than the sight of this same nature bedecked by the hand of civilized man. Wishing only to preserve her beauties we destroy her charm, we rob her of that power which is hers alone, the secret of preserving in eternal age eternal youth'.

Some days were spent in boat expeditions, during which South Port, Port Esperance, and the Huon River were discovered by De Cretin, De La Seinie, and De Luzencay respectively, while surveys, soundings, and astronomical observations were also made. Partridge Island, Huon Island, and Satellite Island were named.

The most important discovery was made by the boat commanded by De Saint Aignan, who, accompanied by Beautemps-Beaupré was dispatched with a crew of 11 sailors and provisions for four days.

Leaving the 'Recherche' on May 18th at half-past 11, with a fresh S. to S.S.E. wind and rain squalls, he made good progress through the canal, and when late in the afternoon he caught sight of the open sea, and saw the waves breaking with violence on the shore, he was satisfied now that there was an open channel between the large island and the mainland (D'Entrecasteaux Channel).

Landing a little after 5 o'clock in a small cove with fine sand at the north of the island, they spent the night, which they felt very cold, notwithstanding the huge fires which they kept up. There they found some canoes 7 to 9 feet long and 3 to 4 feet wide in the middle, tapering to a point at each end. They were made of very thick bark, arranged lengthwise, and tied togeher with rushes or ligneous grass—really only rafts shaped like canoes. There they also saw some native huts, like those which they found at the mouth of the Huon, baskets, kangaroo-skins, &c. The return to the ship was delayed by a head wind, and the next night was passed in great discomfort owing to storms of rain and hail. The following day in the bay discovered previously by De Cretin, he allowed the boat to ground on a sand-bank at the head of the inlet, and in his own words: 'I did not hesitate to strip and leap overboard, and to wade ashore, holding a gun in one hand and a compass in the other. On landing I heard the sea thundering on the other shore, and, crossing a tongue of land a cable's length across, I found myself on the shore of Adventure Bay. The cold did not prevent me from taking several observations nor from making further sketches. Recrossing the same tongue of land through the scrub, some of which was very prickly, I returned to the boat as I had left it'. After two miserable nights of squalls, rain, and hail, their provisions exhausted, they finally regained their ships. During their cruise Saint Aignan and Beautemps had made numerous observations and sketches.

D'Entrecasteaux, anxious to continue his search for La Perouse, thought of availing himself of the favourable winds which were blowing and sailing south, but yielded to the wishes of his officers, who wanted to navigate the ships through the newly discovered strait, hoping, as he did himself, to make perhaps further discoveries. The channel was so sheltered and the breeze so light that it took four days to pass through it, the ship anchoring from time to time in order that observations of all kinds should be made, and that Beautemps-Beaupré should receive every assistance in his chart-making. 'A sailor', he says, 'can never be accused of exaggeration in showing enthusiasm at the sight of a harbour 24 miles long, everywhere safe, without reefs, where one can drop anchor without fear, and approach without danger a cable's length from the shore; of an aspect attractive, although somewhat monotonous at first sight because of the uniform greenness of the trees with which the hills, heaped one upon another as they are, are covered from the very summits down to the water's edge, varied, however, by the picturesque scenes presented by the windings and numerous bays of the channel, and by the streams and rivers which flow into it on the mainland side'.

When the ships had sailed out of the channel, and D'Entrecasteaux was hoping to explore the immense bay to the north, the weather became so bad that he had to give up all thought of doing so, and, doubling Cape Pillar, he set sail for New Caledonia.

The journey from Tasmania was uneventful. The ships discovered new islands, corrected the observations of previous explorers, navigating at no little risk among the dangerous reefs so as to enable Beautemps-Beaupré to complete a fine series of charts, and at the same time making careful search for traces of La Perouse's expedition.

On September 6th they arrived at Amboyna, where at first the Dutch authorities objected to their landing; but the trouble was soon settled satisfactorily. There the crews found a welcome change of food, and enjoyed some weeks' rest after their long and trying voyage.

On sailing from Amboyna on October 13th D'Entrecasteaux had intended, after passing Timor, to make for Shark Bay, on the west coast of New Holland, but strong south-easterly gales carried him to the west. Cape Leeuwin was doubled on December 5th, and about 6 p.m. on December 6th the entrance to a large bay (King George's Sound) was observed. D'Entrecasteaux was very anxious to enter it, but the weather was so bad that he found it impossible to tack and make back to the entrance. Two days later he found himself in the midst of a group of small islands and reefs—the Recherche archipelago—and on December 9th was glad to anchor in Esperance Bay. There some time was spent in effecting repairs to the 'Espérance', and landing parties were dispatched to look for fresh water,

the supply of which had become very low; this search, however, proved a failure. The admiral noted in his diary how poorly supplied with fresh water the south coast of New Holland seemed to be.

The expedition was further delayed by Riche, the naturalist, who was lost for more than two days through his own carelessness and disobedience. The account of his experiences, and how he followed some aborigines whom he saw (fortunately, perhaps, for him he failed to overtake them), is interesting reading, as he describes the various animals, birds, plants, &c., which he met with. Although Riche fully acknowledged himself in fault, and expressed his gratitude for all the care which was taken for his rescue, La Billardière seized this opportunity to launch accusations against the commander in the book which he subsequently published. However distinguished La Billardière may have been as a scientist, his criticisms of his officers and companions was so unfair and spiteful that little credence can be placed in them.

On leaving Esperance Bay the expedition sailed slowly along the southern coast as far as 130° of longitude, when on January 2nd Huon de Kermadec signalled that the 'Espérance' had barely enough water to last her a few days, and that her rudder was in need of repairs; next day, receiving further unfavourable reports from the 'Espérance', and knowing that the water supply of the 'Recherche' was getting low, the admiral decided to make a course for Van Diemen's Land. After a somewhat stormy passage the expedition arrived at South Port on January 21st, 1793, and proceeded to anchor in Rocky Bay; the 'Recherche', keeping too close to the eastern shore, took the ground lightly, but had no difficulty in getting afloat without any damage. It was during this passage that D'Entrecasteaux, from the observations made of the westerly currents, formed the opinion that Van Diemen's Land was an island, and that a strait existed between it and New Holland; he records in his journal that it is his intention later to sail to Point Hicks in order to verify his supposition.

At South Port twenty-two days were spent repairing the ships and laying in a supply of wood and water, while La Billardière and the other scientists made valuable collections of plants, fishes, and animals. While charmed by the country, D'Entrecasteaux complains of plagues of blowflies, which set up putrefaction in all kinds of food, while their buzzing was loud and annoying. He had experienced nothing like them in other parts of the world.

De Welle and Beautemps-Beaupré sailed up the Huon for more than three leagues; they described it as more than one and a half miles wide at its mouth, its course being to the north-west for about 7 miles, then to the north some degrees east for 5 miles. At the bend of the river they found the river covered with swans,

which made no attempt to escape from the boat, even when shots were fired at them point-blank. Port Cygnet also was visited and examined by these officers.

Sailing slowly through the channel, both ships, after passing Satellite Island, grounded near Point Riche, but floated off as the tide rose. The same two officers landed on Bruny Island, where, under the direction of Beautemps-Beaupré, a base was measured on the isthmus in order that exact surveys might be made.

On the 14th February Captain Huon de Kermadec was ordered to send a boat to examine North-West Bay, while Willaumez was dispatched to explore the deep inlets at the bottom of Storm Bay, which the admiral had noticed the preceding year.

Accompanied by Beautemps-Beaupré and provisioned for four days only, Willaumez, on issuing out of the channel, kept to the western side, and entering what he at first thought was an arm of the sea found himself in the mouth of a large river, Rivière du Nord, in contrast to the Rivière du Sud (River Huon). This river, which we now call the Derwent, he ascended for some four leagues, and then returned.

On leaving the Derwent Willaumez kept to the eastern shore, and examined Double Bay (Ralph's Bay); as he coasted along he passed between the mainland and the island called by the French, Willaumez Island, after this distinguished sailor, but now known as Franklin Island, and entered the large bay, to which he gave the name of Baie du Nord (Frederick Henry Bay). By the time he reached the ile Saint Aignan (Slopen Island) food supplies were almost exhausted, but the goodwill of the crew and their readiness to go on low rations encouraged him to persevere. Unfortunately bad weather came on, compelling the boat to run for shelter under a cape (Point Renard)[1], and as there was no improvement next day he had to abandon the attempt to make for East Bay Neck, which was close at hand.

The admiral's instructions had been to discover whether a channel existed, and whether the Maria Islands of Captains Cook and Furneaux were really islands or only a peninsula. Willaumez reported that, although the country was so broken up that a passage might have escaped his observation, he saw land to the east, which made him think that no such channel existed.

The continued absence of this boat and the strong gales which had raged for two days caused the admiral such uneasiness about the safety of his men that he dispatched the 'Espérance' through the D'Entrecasteaux Channel in order that she might send out search parties; fortunately on the fifth night after its departure the boat returned, the crew being exhausted and chilled to the bone.

[1] Point Renard was named after Surgeon-Major Renard, of the 'Recherche'.

Willaumez, although he had failed to discover the supposed channel, described a great series of bays extending in the north to 42·42° and in the east to the meridian of Cape Pillar. 'It seems', says D'Entrecasteaux, 'that all the sheltered havens of New Holland are collected together in the neighbourhood of South Cape, to the east of which are to be found an uninterrupted range of harbours, ports, and bays, which form one vast haven eighteen by fourteen leagues in extent. I do not believe that there is in any part of the world such a great number of excellent anchorages assembled in so small a space'.

On February 21st, 1793, the two ships sailed for Fleurieu (or Oyster) Bay, but were driven by the weather to put into Adventure Bay, which they quitted on February 27th, sailing along the east coast as far as Cape Frederick Hendrick, after which they steered a course for New Zealand.

No landing was made there, and on March 23rd the ships anchored at Tongatabu, in the Friendly Isles, staying there for more than a fortnight. Passing the New Hebrides, they arrived on April 18th at Balade, on the east of New Caledonia, the survey of which the admiral wished to complete; the chart of this coast by Beautemps-Beaupré D'Entrecasteaux describes as one of that scientist's best pieces of work. There they spent nearly three weeks, their stay being saddened by the death of Captain Huon de Kermadec, who had been in bad health for some time. D'Entrecasteaux, who was a personal friend of many years' standing, reproaches himself in his diary for having persuaded de Kermadec to come on this expedition, as his constitution had been much weakened by his long and trying service in the navy, and pays a touching tribute to his character. They buried him at nightfall on the little island of Bouguioue (Observatory Island), no mark being placed on his grave because of the fear that the savages, who were cannibals, might disturb his body. Some years later a cross was erected there by the 'Heroine', a French corvette. This was removed in 1847, as the mark was found to be confusing to navigation, but in 1857 Captain Ville Georges and Dr. Viellard built a small monument of coral on the spot.

D'Entrecasteaux, in his journal, comparing the two islands of Van Diemen's Land and New Caledonia, writes as follows: 'New Caledonia, lying in the tropics and enjoying a most beautiful climate, presents a coast-line bristling with nothing but rocks, and unapproachable. Van Diemen's Land, placed in a high southern latitude, possesses the most magnificent roadsteads and the safest of havens. They are, so to say, the two extremes of good and evil. If we ought not to hope to find as fine harbours as those of Storm Bay, we should flatter ourselves that we shall not encounter a coast as dangerous as that of New Caledonia'.

The impression that the natives of New Caledonia made on the explorers contrasted very strongly with the sentiments which they had formed for those of Van Diemen's Land. The latter, D'Entrecasteaux says, 'offer the most perfect image of a primitive society, where men are not troubled by passion nor corrupted by the vices of civilization; assured of easily finding their sustenance, they enjoy peace and contentment; their open and smiling physiognomy represents a happiness which is troubled neither by importunate reflexions nor by vain desires. The New Caledonians, more advanced doubtless in civilization, have a ferocious character, and are constantly at war with one another. Many of them had recent wounds on their bodies, and the human flesh we saw them eating, which must have been that of their enemies, showed that fighting was of recent date'.

On May 9th D'Auribeau took command of the 'Espérance', and Rossel became flag captain of the 'Recherche'.

As they directed a course toward the archipelago of Santa-Cruz a group of three small islands was observed, one of which, situated to the east, had not been perceived by Carteret. 'We called it "Ile de la Recherche", but we saw it at such a distance that we could not place it on our chart with precision, although we noted its latitude and longitude within some minutes of accuracy', says D'Entrecasteaux. This was the very spot where La Perouse was shipwrecked, as was discovered by Dillon and D'Urville many years later; it is now called Vanikoro. It seemed the irony of fate that led D'Entrecasteaux to give the name of Ile de Recherche to the very island where the French explorer whom he failed to find had been lost.

Pursuing his investigations in Santa-Cruz and the Solomon Group, he could gather no information from the natives of these islands, nor from those of the Lousiades, where he discovered and named some new ones after Rossel, Saint-Aignan, Trobiand, and Riche. A gulf on the south-east of New Guinea he named 'Huon Gulf'.

On June 29th the ships passed through Dampier Strait, and close to the coast of New Britain observed the eruption of a volcano in the sea. By this time the stock of provisions on board was getting low, the wine had become sour, the flour had rotted, the health of the crew was bad, and scurvy was prevalent, so that the admiral decided to sail for Java, which it was becoming daily more urgent for them to reach.

D'Entrecasteaux himself was in a serious condition, suffering from scurvy and dysentery, and on July 8th he became too ill to write his journal, which was continued by Rossel. On the day before his legs had become very swollen, and black spots, which appear towards the end of the disease, had developed. 'We were hoping', says Rossel, 'to land him, for we felt that a rest ashore would do more than anything to restore his health. He refused all our requests, replying

that he would never for the sake of his personal benefit depart from the orders which had been given him in his letters of instruction, that the objects of general utility, and, above all, the interests of the State, must never be sacrificed to private affairs. During the night of July 19th the pain became so violent and caused him such suffering that we perceived the onset of delirium; medicine proved useless. Towards mid-day the alarming symptoms seemed to abate, and we began to flatter ourselves that there might be some hope; but it was not of long duration. He, whose existence had been so precious to us all, became comatose, and died at half-past seven on the night of July 29th'. He was buried with naval honours next day.

Rossel says of him: 'D'Entrecasteaux astonished the most experienced sailors by his boldness in braving the greatest dangers; a boldness which, while it might have passed for rashness in another, was justified in him by the resources of his sound, keen, fertile intellect: the danger which might have taken an ordinary man by surprise was always provided for in his plans, so that the result proved that he could defy it, inasmuch as he was sure of overcoming it'.

Admiral Jurien de la Gravière, who was then a young officer on the 'Espérance', tells how all were overcome with grief and stupor at the news of the death of a commander who was so respected, so beloved, so humane.

After his death nothing but misfortune befell the expedition. On August 20th D'Auribeau took command on the 'Recherche', and Rossel was transferred to the 'Espérance'; but the former, whose health was bad, entrusted Rossel with the duty of bringing the ships to the island of Bourou, where they were provisioned, and where they remained from September 3rd to September 15th. Arriving at Batoum on October 9th, they stayed for forty-eight hours in order to obtain a further supply of fresh food, scurvy and dysentery raging amongst the men, whose sufferings were accentuated by the great heat which prevailed. D'Auribeau, who had again resumed supreme command, brought his ships to anchor in the harbour of Sourabaya on October 19th. The Dutch authorities at first refused them the hospitality of the port, so that after being kept waiting for some days the high command had decided to sail for the Ile de France, notwithstanding the fact that so many of the crew were incapacitated by illness. The reason given by the authorities was that war had now been declared between Holland and the French Republic, the Dutch disregarding the fact that letters of safe conduct had been issued to the expedition on its departure on a voyage of exploration. At the last moment, however, the Council at Batavia announced that they would grant to the French ships the privileges belonging to friendly nations. This permission was subsequently withdrawn and again restored.

In addition to the sufferings of the expedition from famine and disease there was now to be added the political trouble and strife engendered amongst its members by the revolution and the execution of Louis XVI. Two parties were formed: the Royalist group, which included most of the officers, many of whom were of the old noblesse; and the Republican, which embraced most of the scientists, like La Billardière, Riche, and others, who had been ardent encyclopaedists. The crews took little or no part in the dissensions; knowing that they were under the command of brave officers they did their duty loyally as sailors of the navy of France.

After the American War of Independence, in which it had distinguished itself, the French navy was in a high state of efficiency, both as regards ships and personnel, and France might have once more contested the empire of the sea. At the Revolution, however, many of her best officers and sailors, being of royalist sympathies, were driven from the service, and the navy was brought into such a state of chaos that even Napoleon himself failed to restore its ancient prestige. It was this loss which accounted largely for the failure of the French navy in the Napoleonic wars.

While D'Entrecasteaux lived his genius, and the respect and affection in which he was held by all, prevented any quarrels between members of the expedition. D'Auribeau was of a different temperament; he was of arbitrary disposition, and was feared and disliked; possessed, as Jurien de la Gravière says, of an ungovernable pride, he was totally unfitted for supreme command. He had no sympathy for modern ideas; he disliked the scientists being on board his ship, and was very annoyed with them when they installed their bread-fruit trees on his quarter-deck.

With the permission of the Batavian Government, officers and crew began to live ashore. They were able at first to pay their way by selling the merchandise which they had brought with them for barter; when this money was spent they borrowed from the Dutch Trading Company on the security of their pay, which had been accumulating for them in France for more than two years. Soon, however, French credit had ceased to exist, and the Batavian Government took possession of the ships as a guarantee for the borrowed money. By this time the morale of the expedition was being sapped by the idle life ashore; quarrels became more frequent, the staffs ceased dining together, each went his own way. To make matters worse D'Auribeau seized the opportunity to confer the Cross of Saint-Louis on three of the officers, at the same time demanding the oath of fidelity to the King. With the connivance and support of the Dutch authorities the two corvettes were surrounded by men-of-war with loaded guns, lists of proscription were drawn up, detachments of troops made prisoners of the men ashore, and the white flag was hoisted and saluted. This day, February 20th, 1794, may be considered as the end of the expedition. The officers who were not royalists, the savants, and the naturalists were detained in fortresses, while half the crew were sent as exiles

into the interior of Java, where many succumbed eventually to fever and dysentery. Of the original 219, 99 died. Jurien de la Gravière and his friend Beautemps-Beaupré were included in the proscription, but were afterwards released at the request of D'Auribeau. Fortunately the hospitality of the Dutch settlers allowed the victims of this *coup d'etat* to endure their captivity in comparative comfort, and soon the news of French victories—the English, under the Duke of York, beaten at Hondschoote, the Austrians at Wattignies and Fleurus, Belgium reconquered, Holland invaded—completely changed the outlook. In 1794 D'Auribeau died at Samarang and two officers at Batavia, while two others joined the Dutch navy, which was now a friendly power, Holland having become the Batavian Republic, an ally of France against England.

Rossel, accompanied by the remaining officers, sailed from Java in January, 1795, on board a Dutch convoy, arriving at Table Bay on the 4th of April, where Jurien de la Gravière transhipped from the 'Dordrecht' to the 'Hougly' in order to rejoin Rossel, who was carrying with him all the papers, charts, and reports of the expedition. While his commander was ashore the 'Hougly' sailed unexpectedly with Jurien de la Gravière and de Trobiand on board. Rossel had to take passage by a brig-of-war, which was captured near the Shetlands, and he himself was taken to London as a prisoner. In the meantime the 'Hougly' was seized near Saint Helena by an English squadron under Commodore Essington, who took possession of all the papers, charts, and collections of the expedition, notwithstanding the formal protests of the French officers, and in violation of the pledges of neutrality and safe conduct furnished by the English Government in 1791.

There is no doubt that the value of D'Entrecasteaux's papers and charts were recognized by the English Government, and that they made use of them later for the expeditions which they sent to Australia and Tasmania. They learned from him his opinion that Tasmania was an island, and it was following his indications that Bass and Flinders made their discoveries. Bruni Island, D'Entrecasteaux Straits, the Huon, the Derwent, in fact most of the south coast of Tasmania, was French by discovery. The Home Government realized this, and foresaw the probable claims by France; to cut short all doubt, therefore, the Governor of New South Wales dispatched a detachment of troops in 1803, who hoisted the British flag, and took possession of that land by the Derwent River which Willaumez had discovered 10 years before.

After the Peace of Amiens, in 1802, the papers were returned to Rossel, and the collections of natural history were restored, so La Billardière tells us, through the generous intervention of Sir Joseph Banks with the Government.[1]

[1] La Billardière's collection consisted of 22 boxes, containing specimens of plants, flowers, insects, fish, reptiles, birds, small kangaroos, and mineralogical specimens.

The bread-fruit trees which had been collected by the expedition in the Friendly Isles were taken eventually to Batavia; La Haye transported them to the Ile de France in 1797, where some were placed in the botanical gardens and multiplied. Many of these were distributed to other colonies, while some of the original trees were taken to Paris by La Haye.

During their two visits D'Entrecasteaux and the members of his expedition had frequent meetings with the Tasmanian natives, and were on the most friendly terms with them. He and La Billardière have left long accounts of them, their character, and customs, much of which Ling Roth quotes in his book on the aboriginals of Tasmania. A vocabulary of their language was also compiled.

Huon de Kermadec (Jean Michel) was born at Froment, near Brest, on September 12th, 1748, the descendant of an old and noble family of Brittany, whose chateau near Landerneau dated from 1270 A.D. Many of the members of this family had served in the French navy. He was admitted as a page into the royal household in 1762, and into the navy four years later. As ensign on the 'Sensible', he fought, as did his uncle, in the battle of the Ushant; as lieutenant he served under the Comte d'Estaing at the capture of Grenada and the siege of Savannah, and with Motte-Picquet against Cornwallis. Knight of Saint Louis in 1781, he sailed under D'Entrecasteaux in his well-known voyage to the Indian and China seas. On his return he was made a member of the Royal Academy of Marine, and read before that body his journal of the voyage. Chosen by D'Entrecasteaux as his second in command of the expedition which was fitted out to search for La Perouse, he was promoted to the rank of post-captain. He died on the 6th of May, 1793, at Balade, in New Caledonia.

In Tasmania the Rivers Huon and Kermandie (corruption of Kermadec) bear his name; some small islands to the north of New Zealand and a bay in New Guinea were also named after him.

Several members of this old family, Comte Reges de Kermadec, Colonel de Kermadec, and others are still living in France; a small miniature of Huon as a child is in the possession of a relative.

Rossel (Elizabeth Paul Edouard) was born at Sens on September 11th, 1765, entered the navy in 1780, and served in the Antilles under the Comte de Grasse. Attached to D'Entrecasteaux in 1789, he so perfected himself in his profession that he was promoted lieutenant in 1789, and chosen for the expedition of 1791. On the death of De Kermadec he succeeded D'Auribeau in the command of the 'Recherche'. The death of the admiral, followed later by that of D'Auribeau, placed him in supreme command. As his

vessels were still detained by the Batavian Council of State, Rossel sailed on a Dutch vessel, taking with him all the papers and plans of the expedition. Captured by the English north of Shetland, and taken to London as a prisoner of war, he was released after some months. He was so overcome, however, by grief and horror at the murder of his mother on the guillotine that he did not return to France until the Peace of Amiens. At the request of Napoleon he edited and published the account of D'Entrecasteaux's expedition. He subsequently published a book on nautical astronomy, which was translated into several languages; in 1812 he was elected a member of the Institute of France, the Legion of Honour was conferred on him in 1822, and he was gazetted rear-admiral on his appointment as Director of the Department of Charts and Plans of the Navy.

In addition to the works mentioned, he published many other scientific treatises, and was one of the founders of the Geographical Society of France. Rossel was an artist of great distinction, and painted many pictures representing naval scenes and episodes, some of which are to be found in the museum of Versailles and in the Ministry of Marine at Paris. He died on November 20th, 1829.

Beautemps-Beaupré (Charles François) was born on August 6th, 1766, at Neuville-au-Pont, and studied under his relative Nicolas Buache, who was Geographer-Royal. At the age of 19 he was entrusted by the Minister of Marine, the Comte de Fleurieu, with the work of drawing the charts of the 'Neptune'. In D'Entrecasteaux's expedition he distinguished himself not only by his astronomical and geometrical observations and discoveries, but by the exactitude of his charts. Returning to France in 1796, he continued his work, and published the atlas of D'Entrecasteaux's voyages in 1807.

Napoleon, recognising his talent, entrusted him with the hydrographic survey of the French coast, the North Sea, the Adriatic, &c.

From 1816 to 1833 Beautemps-Beaupré continued his work, producing the French 'Pilot', a magnificent atlas in six volumes, which put all other charts out of date because of the precision of its astronomical, geodesic, and nautical observations. He also collated and corrected on a very large scale the whole of the charts of the French coasts in 527 volumes, which are deposited in the archives of the French navy. His pre-eminent work for navigation won for him from his English confreres the title of 'The father of hydrography'.

He was named Knight of Saint Louis and of Saint Michael, Grand Officer of the Legion of Honour, member of the Department of Longitudes, and his bust was placed in the great gallery of the Department of the Navy by command of the Emperor Napoleon III. two years before his death in 1854.

Willaumez (Jean Baptiste) was born on August 7th, 1763, at Palais, in Belle-Isle, the son of a coastguard officer. Left a penniless orphan, with five younger brothers, he educated them for the navy, in which service they all lost their lives. Embarking at the age of fourteen as a pilot's apprentice on the 'Bien-Aimé', commanded by Bougainville, he rose rapidly, until in 1781 he was pilot on the 'Amazon', commanded by La Perouse, who put him on board with a prize crew, to take to Lorient an English ship which he had captured. In 1783 a frigate of 32 guns in which he was serving was taken by the English 'Saint Margaret', of 44 guns, but next day was retaken by the French. Willaumez, who had received two severe wounds in the fighting, was promoted to the rank of senior pilot, although he was then only 19 years of age. Skilled in the practical part of his work, he wished to perfect himself in theory, and studied nautical astronomy and mathematics with this end in view; but he would probably never have become a commissioned officer had it not been for the Revolution, which in 1791 made him an ensign.

In the expedition of D'Entrecasteaux he was made a navigating officer, and the admiral promoted him to lieutenant, conferring on him the Cross of Saint Louis at a later date.

When the French ships were seized by the Dutch at Sourabaya, Willaumez was detained for some time, but eventually, with some of his companions, made his way to the Ile de France, which was then being blockaded by an English squadron. The French, sailing out with two frigates, defeated the English, and raised the blockade. Willaumez, who had been again wounded, was entrusted with the duty of carrying dispatches to France. Promoted post-captain in 1795, he was engaged in almost continuous fighting, and captured nineteen English ships in all. Officer of the Legion of Honour in 1805, and rear-admiral, he commanded a light squadron, and with a smaller ship fought the English three-decker 'Hibernia', commanded by Lord Cornwallis. After serving at the Cape and the West Indies he returned to Europe. Vice-admiral in 1819, Knight of Saint Louis and Grand Officer of the Legion of Honour, he was made a peer of France and given the title of Comte. He died in 1845.

He was the discoverer of the River Derwent and the various bays at its mouth. It is a matter of regret that his name is unknown and unremembered in the place which he discovered and charted.

Jurien de la Gravière (Pierre Roch) was born on November 5th, 1772, at Gannat, and joined the navy at the age of 14 years. Volunteering for D'Entrecasteaux's expedition, he was made ensign on the 'Espérance'; surviving the tropical diseases which carried off so many of his companions, he was taken prisoner when the Dutch ship on which he was returning to France was captured by an English man-of-war near Saint Helena. On his release he rejoined the navy, in which he gained rapid promotion, becoming post-captain

in 1803. In command of three frigates, he defeated an English squadron of six ships at Sables d'Olonne, in 1809, after three hours' hard fighting. Subsequently he wes sent to retake possession of the Ile de Bourbon. Rear-admiral in 1817, vice-admiral and peer of France after the July revolution, he had conferred on him the honour of the Grand Cross of the Legion of Honour. He died in 1849. He published an interesting book of memoirs—'Les Souvenirs d'un Amiral'.

Amongst the crews of the two ships were three interesting people, the brothers Raoul, and the purser of the 'Recherche'.

The elder brother, *Raoul (Joseph François)*, was born at Tréguier in 1766; joining the navy as a ship's boy he soon saw active service. Pilot on the 'Recherche', he discovered the island (29 S. latitude, 179 E. longitude) to which his name was given. Taken prisoner and detained in Batavia, the Cape, and England, he rejoined the navy in 1796 with the rank of ensign, and served in the expedition to Ireland. In the terrible fighting of 1798 he received seven severe wounds and lost his right eye, and for the second time was made prisoner. On his regaining his liberty he was, in 1799, promoted to the rank of lieutenant, and employed in the depot of charts and plans. Commander on the 'Imperial' in 1804 at San Domingo, he received three more severe wounds; at Guadeloupe he captured an English vessel; and despatched on a mission to Java on the 'Medusa' he defeated and captured the 'Bellona', which lost 72 men. Post-captain in 1812, he took part in the bombardment of Antwerp, and died in 1816 while on active command. His service record showed seventeen wounds and the loss of an eye.

Cape Raoul, on the south-east coast of Tasmania, was named after this gallant sailor.

His younger brother, *Raoul (Ange-Aimé-Marie)*, was born in 1769, and shared with his brother in the hydrographic work of the expedition under the direction of Beautemps-Beaupré. Ensign in 1797, lieutenant in 1803, he was attached to the general depot of the Marine in 1815, and continued to work under Beautemps-Beaupré. He died in 1843.

Girardrin (her real name is unknown), the purser of the 'Recherche', was the first white woman to visit Tasmania, and probably the first to visit Australia.

Her story was as follows: She was the daughter of a respectable merchant of Versailles, and having been seduced by some lover fled from her father's anger. Abjuring her sex, and dressed as a man, she managed, by means of a letter of recommendation, which she obtained from the sister of Captain de Kermadec, to obtain the position of purser. She was most attentive to her duties, but kept apart as much as possible from the rest of the crew, and resented any familiarity. On one occasion a young volunteer teased her on account of her hairless face, and said jokingly that she must be a

woman; considering herself insulted, she challenged him to a duel, and fought bravely, receiving a wound in the forearm. Notwithstanding the fatigues, the bad food, the scurvy, and the dysentery which laid others low, she not only kept on duty, but took an active part in nursing her sick comrades. She was left with Jurien de la Gravière and de Longuerue, the last of the expedition to sail for France. De Longuerue, whom she nursed, succumbed; then she herself fell sick and died, her death being as stoical as had been her life. The night before she died she told Jurien the whole history of her life.

LIST OF OFFICERS, SAVANTS, AND ARTISTS OF THE FRIGATES 'LA RECHERCHE' AND 'L'ESPÉRANCE', COMMANDED BY M. D'ENTRECASTEAUX

'La Recherche'

BRUNI D'ENTRECASTEAUX, rear-admiral

Lieutenants

D'HESMIVY D'AURIBEAU, made post-captain
DE ROSSEL
DE CRETIN
LA FRESNAYE DE SAINT AIGNAN
SINGLER DE WELLE
WILLAUMEZ

Surgeon-Major

RENARD

Chaplain

VENTENAT, canon, naturalist

Midshipmen and Volunteers

MERITE, volunteer, made sub-lieutenant
ACHARD DE BONVOULOIR, midshipman, made sub-lieutenant
DE LONGUERUE, midshipman, made sub-lieutenant
FORESTIER, made volunteer
DE LAMBERT, made volunteer
DESLACS, made volunteer

Savants, &c.

BEAUTEMPS-BEAUPRÉ, hydrographer
L'ABBÉ BERTRAND, astronomer, disembarked at the Cape of Good Hope
LA BILLARDIÈRE, naturalist
DESCHAMPS, naturalist
BIRON, draftsman
LA HAYE, gardener, botanist

'L'ESPÉRANCE'

HUON DE KERMADEC, commander, made post-captain

Lieutenants

DENIS DE TROBRIAND
LA SEINIE
LA GRANDIERE
DE LUZANCAY
LA MOTTE DU PORTAIL
LE GRAND

Surgeon-Major

JOANET

Chaplain

PIERSON, benedictine, astronomer

Midshipmen and Volunteers

LEIGNEL, volunteer, made sub-lieutenant
JURIEN, volunteer, made sub-lieutenant
DE BOYNES, midshipman, made sub-lieutenant
FILTZ, made volunteer

Savants, &c.

JOUVENCY, geographer
RICHE, naturalist
BLAVIER, naturalist, disembarked at the Cape of Good Hope
ELY, draftsman, disembarked at the Cape of Good Hope

The following works have been consulted in the preparation of this paper:—

Voyage de d'Entrecasteaux envoyé à la recherche de Lapérouse, par de Rossel.
Voyage à la recherche de Lapérouse, par le citoyen Labillardière.
Souvenirs d'un amiral, par Jurien de la Gravière.
Gloires maritimes de la France, par A. Doneaud et P. Levot.
D'Entrecasteaux, par Le Baron Hulot.
Personal communications from Colonel de Kermadec and others.
The Cambridge Modern History.
A History of Europe, by H. A. L. Fisher.

NOTE

In connection with the memorial to D'Entrecasteaux recently unveiled at Gordon, some controversy has taken place in the press in regard to his correct rank and name. There is no doubt about either, as documentary evidence is clear.

On 1st July, 1792, by command of Louis XVI., D'Entrecasteaux was gazetted a vice-admiral. There is in the transactions of La Société de Géographie, 1894, a monograph by Baron Hulot, in which D'Entrecasteaux is described as vice-admiral. The documents proving this are—

(1) Archives de la Marine, D'Entrecasteaux dossier personnel.
(2) La Liste générale des officiers de la Marine, 1791-95, année 1792.
(3) Une lettre datée de 9 Brumaire an XIII., preserved in the archives of the Ministère de la Marine, dealing with his pay as vice-admiral.

The name de Bruni D'Entrecasteaux has been written in different ways—Bruni or Bruny, D'Entrecasteaux or Dentrecasteaux. The orthography of his baptismal name and of his signature should undoubtedly be observed.

D'Entrecasteaux in his signature uses the D' (apostrophe).

His baptismal certificate, copied from the register of baptisms of the Parish of Sainte Magdeleine d'Aix, is as follows:—'Noble Antoine—Raymond—Joseph de Bruni D'Entrecasteaux, fils de messire Jean-Baptiste de Bruni, Marquis D'Entrecasteaux, Président à mortier au parlement de ce pays de Provence, et de dame Dorothée de Lestang—Parade, apres avoir été ondoyé le huit November, 1737, a reçu le supplément des ceremonies de baptème ce jourd'hui vingtième Janvier, 1738.'

D'ENTRECASTEAUX ENFANT

LE CHEVALIER D'ENTRECASTEAUX (VERS 1774)

NATIONAL MUSEUM OF VICTORIA

D'ENTRECASTEAUX (1791)

BEAUTEMPS-BEAUPRÉ (1808)

NATIONAL MUSEUM OF VICTORIA

A Survey of Eucalyptus Species in Tasmania

By

R. G. Brett, B.Sc.

(Read 8th November, 1937)

Plates XV-XVII

Introduction

The following notes, descriptions, and suggestions have been made in field, herbarium, and nursery work in connection with the Biological Survey of Tasmania in progress at the present time.

Difficulties of Eucalypt Study

The genus *Eucalyptus* has engaged the attention of some of the world's greatest botanical taxonomists during the past 150 years, and has been the subject of endless controversy. Some of the troubles have arisen from the following causes:—(1) The botanists who first collected in Australia and Tasmania, or who worked on existing collections, were not in possession of our modern knowledge of plant cytogenetics, and consequently could not make adequate allowance for the mutational and hybridization factors which are responsible for the high degree of species variability. Before a type description can be satisfactorily made, it is necessary to review material collected over a wide area to determine the limits of variation and the possible existence of interspecific hybridization. It may thus take several years' field and nursery experience of a group suspected to constitute a species before a safe type description can be made. Many of the early types were founded by European botanists on fragmentary and imperfect material sent from one tree only by Australian collectors. In other cases descriptions were made from trees under cultivation in Europe. This is very unsafe, as some species behave anomalously when under artificial cultivation. (2) Although during the past 30 years our field knowledge of the

genus has enormously increased, workers have continued to found species on the old lines, and we have witnessed the elevation of pure hybrid types to specific rank. It is during these years that the failure to study the effects of interspecific hybridization has prevented real progress, and the difficulties have almost increased rather than diminished. It is true that in this time many true species have been discovered and the range of others extended, e.g., the recognition of *E. rubida* in Tasmania by Maiden. Work of great importance has been done by Maiden and others in describing seedlings. The influence of this is to be seen in the 'Key to the Eucalypts', by Blakely (1934). (3) The synonomy has been complicated to an inordinate degree by the fact that many of the type specimens are in the great European herbaria and are not available to Australian workers. The existence of eucalypt collections in European centres has made the question of priority a very vexed one. As an example of this note the loss of the old established name *E. amygdalina* Labill., and the change to *E. salicifolia* (Sol.) Cav. The immense size and protean character of the genus make inherent difficulties of synonomy in addition to the aggravation referred to above. Workers in the field of Tasmanian eucalypts must bear these three points in mind.

Species Review

The Tasmanian species have been surveyed with two objectives in view: (1) an attempt to isolate biotypes, (2) the detection of interspecific hybridization and its effect upon variability. An endeavour has been made to isolate polymorphic hybrid swarms, and determine the effect of hybridization on the origin of new eucalypt species. The term hybrid is frequently used in what follows. It is to be understood strictly in the sense of interspecific (undefined)[1] hybrid. The task of attempting to isolate Mendelian and the many other hybrid types discussed by cytologists and cytogeneticists has not been undertaken. This is a rich field for future investigation. In the course of field work both in Tasmania and on the mainland of Australia phenomena have been noted which indicate the possible existence of Mendelian hybrids.

In 'A Key to the Eucalypts', Blakely gives 32 species for Tasmania. Of these it is claimed that *E. Huberiana* Naudin (see *E. viminalis* in check list) and *E. nitida* Hook., f., are not in Tasmania. With regard to *E. nitida*, readers are referred to the 'Critical Revision', Maiden, pt. 38. p. 235, where an incomplete description is given. Specimens collected by R. H. Cambage from near the summit of Mt. Roland are quoted in the range for Tasmania. By the kindness of Mr. W. F. Blakely I have been permitted to see one of these specimens, and have no hesitation in saying that it is *E. coccifera* var. *parviflora*. This variety is widely

[1] See Darlington, 1932.

distributed at alpine levels in the district of Mt. Roland. A fuller description is given in 'A Key to the Eucalypts', and Risdon is quoted as a district. I have not seen the specimens on which this statement is made, but suggest that they are hybrids of *E. Risdoni* with *E. viminalis*. The former species produces two very different hybrid swarms at Risdon, one with the *E. viminalis* and the other with *E. salicifolia*.

The second specimen collected by Gunn would match one of the many hybrid forms of *E. Risdoni*. In connection with this supposed species it should be noted that some of the hybrid forms of *E. Risdoni* show marked similarities to *E. coccifera* or its variety. Thirty-one species are discussed in the check-list, which includes an additional species, *E. divaricata* McAulay & Brett, sp. nov., and excludes *E. Huberiana* Naudin and *E. nitida* Hook., f.

It is suggested in this paper that the 31 species described below are composed of the following types: (1) simple or compound Linnaean species, (2) polymorphic species, (3) hybrids. The terms 'compound species' and 'polymorphic species' are used for convenience. The former is intended to describe groups which obviously contain two or more biotypes, e.g., *E. pauciflora* Sieb.; and which can be split into two or more species or varieties as the result of future investigation. The latter describes groups which are of obvious hybrid origin, including races in varying degrees of fixation. A detailed study of *E. Risdoni* and its many hybrid forms has been responsible for this suggestion (see note on *E. Risdoni* Hook., f.).

Group 1 (Simple or Compound Species)

1. *E. ovata*
2. *E. aggregata*
3. *E. globulus*
4. *E. cordata*
5. *E. viminalis*
6. *E. rubida*
7. *E. urnigera*
8. *E. subcrenulata*
9. *E. vernicosa*
10. *E. Archeri*
11. *E. divaricata*
12. *E. Gunnii*
13. *E. Perriniana*
14. *E. obliqua*
15. *E. gigantea*
16. *E. regnans*
17. *E. Sieberiana*
18. *E. salicifolia*
19. *E. tenuiramis*
20. *E. linearis*
21. *E. Risdoni*
22. *E. pauciflora*
23. *E. coccifera*

Each description includes one or more biotypes. Seedlings exhibit what may be termed normal variability for a eucalypt species as opposed to hybrid segregation.

Group 2 (Polymorphic Species)

24. *E. Dalrympleana*
25. *E. Johnstoni*
26. *E. Simmondsi*
27. *E. Tasmanica*

Each description includes a group of races which have probably arisen by hybridization, and are either fixed or are in process of becoming stabilized. Seedlings exhibit normal variation or varying degrees of hybrid segregation.

Group 3 (Interspecific Hybrids)

28. *E. unialata*	30. *E. Irbyi*
29. *E. biangularis*	31. *E. taeniola*

The types represent an intermediate between two biotypes, and are probably in the F_1 generation. Seedlings exhibit a high degree of hybrid segregation (see Plate XV). The trees do not form pure stands exhibiting normal variability, but are isolated and difficult to locate, and are never found outside associations of the generating species. The elevation of these hybrids to specific rank makes key compilation unnecessarily difficult. The interesting *E. globulus* × *ovata* described by Prof. A. L. McAulay in the same volume of these proceedings, Rodway's var. *Harrisoni* of *globulus (E. globulus* × *cordata)*, *E. Sieberiana* × *obliqua*, and several other outstanding cases would equally justify specific rank.

Note on Eucalyptus Risdoni Hook., f.

(See also *E. Risdoni* Hook., f., in the Check-list)

No eucalypt species presents more difficulty than *E. Risdoni* Hook., f., and its var. *elata* Benth. (*E. Tasmanica* Blakely). To understand the problems associated with it the following points, summarizing its history and opinions held by different botanists with regard to it, should be noted:—

(1) The type was described by Hooker (1847) on material from Risdon, and is beautifully figured in his 'Flora of Tasmania'. It is intended to cover the trees which maintain entirely opposite foliage.

(2) Bentham, writing later on the same species, extended the description to include the trees which are practically entirely covered with opposite foliage but carry a few alternate leaves.

(3) Mueller united *E. Risdoni* Hook., f., with *E. salicifolia* Cav. (*E. amygdalina* Labill.).

(4) The type has a very limited distribution (see check-list).

(5) The protean complex of forms which pass rapidly from the opposite to the alternate leaf stage, and often assume the dimensions of large trees, has a wide distribution.

(6) This was identified by Hooker as *E. radiata* Sieb. He described and distributed five varieties of it.

(7) Bentham described in the 'F. Aust.' the same complex as *E. Risdoni* Hook., f., var. *elata*. It went under this name until the species *E. Tasmanica* was founded by Blakely (1934).

(8) Rodway supported the view that *E. Risdoni elata* is simply *E. Risdoni* Hook., f., in better soil conditions than obtain at Risdon.

(9) On the basis of oil determinations Baker and Smith (1912) united *E. Risdoni* Hook., f., with its variety *elata* and the variety *hypericifolia* of *E. salicifolia (E. amygdalina)*, at one time regarded by Rodway as *E. hypericifolia* R. Br.

It is suggested in this paper that Hooker's original type is the biotype, and not merely a tree prolonging the juvenile condition, and that departures from this type, slight or extensive, are due to hybridization.

The effect of soil conditions is still an open question, but in field observation I find little to support the view stated in (8). At Risdon there are trees of 20 feet or higher which have been protected from fire, and which retain the paired-leaf condition to the ultimate branchlets; they give every sign of flourishing just because they are in patches of better soil than exists in the average portion of the stand. The soil conditions on the upper side of the Huon-road stand of *E. Tasmanica*, as far as can be judged from the road-cutting, are little, if at all, better than those at Risdon. The trees at Risdon have been destroyed by fire at least once, as many of them grow mallee fashion from blackened root stocks. In the middle of this stand it could be said that umbels in the opposite leaf stage is the most characteristic condition. A similar stand of *E. Tasmanica* Blakely exists on mudstone near Cambridge, on the southern edge of the *E. Risdoni* distribution. There is the same destruction of the original stems as at Risdon, but very few umbels can be found in the opposite leaf stage. It is difficult to account for this on soil conditions alone. The tendency to flower in the opposite leaf stage has apparently vanished when we go as far south as the mudstone flats on the top of Tasman's Arch. It is significant that the districts south of Cambridge represent some of the oldest well-settled areas, and would probably contain an abundance of introduced insects that might aid hybridization.

The forms which connect the Risdon-Bellerive distribution with the comparatively stable types on Tasman's Peninsula show a much higher degree of polymorphism than those on the Huon-road. It must be recognised that if the lastmentioned and similar stands were created by hybridization, as is suggested below, this must have occurred long before the settlement of Tasmania. It is possible, then, that the high degree of polymorphism exhibited by the South-East Coast *E. Tasmanica* is due to secondary hybridization on what

were once stable races. To support this it should be noted that *E. Tasmanica* forms segregating hybrid swarms with *E. salicifolia* near such a long-settled district as Rokeby. The attempt to deal with such polymorphism is discussed fully below.

There is no question of challenging Messrs. Baker and Smith in their opinion with regard to the identities stated in (9). The conclusion is undoubtedly correct from the point of view of an oil classification. But it is very difficult to follow them in their statement that 'the Mt. Wellington trees differ in *minor* respects only, botanically or chemically, from the smaller trees or shrubs' (at Risdon).

It is very significant that the seedlings of the opposite-leaved *E. Risdoni* are much less viable than those of *E. Tasmanica*. As far as can be judged, the latter exhibit a remarkably increased viability, that might be due to what cytologists call 'hybrid vigour'.

With regard to the taxonomy of *E. Risdoni* Hook., f., and its supposed variety *elata*, it should be noted that Hooker's attempt to see five varieties of a different species from his own *E. Risdoni* is significant. Maiden has shown that four of these varieties are var. *elata* Benth.; the fifth he thought to be an example of what is now called *E. nitida*, Hook., f. (see above). The suggestion is made in this paper that all attempts to gather these forms under one or even several species will produce results that are most misleading. A study of Plate XVI must convince any but a most prejudiced observer that to classify all these forms as examples of a single species or variety is wrong. It is evident that the description *E. Tasmanica* Blakely does not cover the complete range. The difficulty of including all the forms under one species in a key is very great. The most satisfactory guide to further investigation is to class the whole complex of forms under what I have for convenience called a polymorphic species (Group 2 above).

Mueller's view that *E. Risdoni* and *E. salicifolia* are the same indicates the serious lack of field knowledge which hampered early workers. It was doubtless arrived at by the examination of intermediate hybrid forms which connect the two species, and may be the origin of Prof. Ewart's statement quoted below under *E. Risdoni* in the check-list.

The important question of terminology must be raised at this stage. Following Cockayne and Allen, whose valuable work on hybridization in the New Zealand Flora has been an important guide in preparing these notes, polymorphic swarms of hybrid origin are represented by the symbol × preceding the generic name. The specific names are compounded of two or more words, and are intended to indicate the main generators of the swarm. Thus ×*E. Risdelata* (formed by fusing the words *Risdoni* and *elata*) represents the whole complex at present imperfectly described by *E. Tasmanica* Blakely. When a particular specific influence can be

observed, the species name is fused with *Risdelata*. Thus the stand on the Huon-road referred to above is mainly ×*E. Risdo-salicilata*. Other examples are to be noted on Plate XVI. When an unknown member of the section macrantherae is apparently present, as is strongly suggested by the seedlings from many trees near to and on Tasman's Peninsula, the swarm is described as ×*E. Risdomacranthelata*. It should be noted that ×*E. Risdelata* = *E. Risdoni* × .... one or more species not known or stated.

At Risdon direct hybridization can be observed, as, for example, in the forms that have been classified as *E. tenuiramis* Miq. In this case the swarm would be defined as ×*E. Risdosalicifolia* (the affix *elata* being dropped). A second swarm, ×*E. Risdoviminalis*, can be observed in the same locality. Note the difference between ×*E. Risdoviminalis* and ×*E. Risdovimelata*.

These notes and terminology are given more with a view to show the lines on which investigation is proceeding, and are based upon field and nursery experience. No attempt is made here to do other than give examples and show the kind of swarm that can be isolated from the ×*E. Risdelata* complex. Descriptions will be undertaken when seedlings at present under cultivation are at a more advanced stage.

Similar polymorphic swarms to that described above as ×*E. Risdosalicifolia* exist in connection with the species of Group 3. Further investigation will be required before complete descriptions of the elements of these can be given (see Plate XV and *E. viminalis* in the check-list).

An extension of terminology is obvious. The swarm connecting *E. viminalis* and *E. globulus* can be described as ×*E. vimiglobulus*. Thus *E. unialata* Baker and Smith is suggested as ×*E. vimiglobulus* (name of author) *unialata* Baker and Smith. In these cases the second name indicates the F_1 generation, and not part of the segregating swarm. It is certain that no real progress will be possible until types such as those of Group 3 are recognised as of definite hybrid origin and future additions of the kind are rendered impossible.

Summary of Suggestions

1. *E. Risdoni* Hook., f., as originally described, is the biotype.

2. It constitutes a weak stock. Its adaptability to xerophytic conditions enables it to thrive on mudstone, where the more vigorous competing species are considerably checked.

3. Its viability has been strengthened by various stages of hybridization until in some cases stabilized races capable of producing tall, well-timbered trees have been evolved.

4. This view of the origin of *E. Risdoni* var. *elata (E. Tasmanica)* in the present state of experimental knowledge accounts

for the increased vigour as satisfactorily as the soil type theory, and better explains why *E. Tasmanica*, as well as *E. Risdoni*, is confined to mudstone formations. (One mudstone deposit cannot substantially differ from another in fertility.)

5. The hybridization may have occurred at different intervals of time. Stable races are probably of ancient origin. Such unstable polymorphism as exists on the South-East Coast may be due to secondary hybridization occurring since the settlement of Tasmania.

6. Departure from the connate juvenile leaf condition and the appearance of alternate leaves, however few, are the first indications of hybridization.

7. The multiplicity of forms thus produced cannot be satisfactorily described by Linnaean species or varieties of such species, but are best regarded as constituting a polymorphic complex, described above as a polymorphic species (Group 2).

8. A suitable terminology to describe such a polymorphic complex is suggested above.

Key to the Eucalypt Species in Tasmania

In the present imperfect state of our knowledge it has not been possible to isolate sharply the biotypes, hence the key below allows the admission of hybrids close to the biotypes. The complex of forms described above as $\times$*E. Risdelata* is included for the sake of convenience under the name *E. Tasmanica*. A study of the means adopted to do this should indicate that there is a marked departure here from the case of a clearly defined simple species like *E. rubida*.

Determination has been necessary in some cases by simple statistical estimates, hence it is important to realize that imperfect material is liable to give misleading results. Due allowance should be made for colour changes in a specimen when dried. Provided suitable material is examined, it is hoped that failure to get a result on this key with the aid of the check-list indicates (*a*) an introduced species, (*b*) a member of an F_1 generation not listed in Group 3, (*c*) one of the segregating hybrids in a polymorphic swarm, (*d*) a new species.

Key to Sections

A. Anthers oblong to obovate; gland large, occupying the upper part of the connective	Section I, *Macrantherae*
B. Average number of flowers in umbel exceeding three	Subsection I, *Tereticornes*
BB. Umbeds one, two, or three flowered	Subsection II, *Parallelantherae*
AA. Anthers reniform; gland small and terminal	Section II, *Renantherae*

KEY TO SPECIES

SECTION I.—MACRANTHERAE

Subsection I.—Tereticornes.

A. Leaves ovate to ovate-lanceolate, often strongly undulate; average maximum width exceeding 2·5 cm. ..... *E. OVATA* (1)

AA. Leaves lanceolate; average maximum width under 2·5 cm. ..... *E. AGGREGATA* (2)

Subsection II.—Parallelantherae.

A. Umbels predominantly one-flowered, occasionally two or three flowered.

B. Leaves lanceolate to falcate-lanceolate, 10-30 x 2-9 cm., or larger, subvernicose ..... *E. GLOBULUS* (3)

BB. Leaves ovate to oblong-lanceolate, 2-4 x 1·5-2 cm., vernicose ..... *E. VERNICOSA* (9)

AA. Umbels predominantly three-flowered, occasionally two or one flowered.

C. Umbels axillary in opposite leaves.

D. Leaves glaucous.

E. Leaves connate at base ..... *E. PERRINIANA* (13)

EE. Leaves cordate, sessile, average length less than 8 cm. ..... *E. CORDATA* (4)

EEE. Leaves oblong to oblong-lanceolate, sessile, average length exceeding 8 cm. ..... *E. GLOBULUS* (3)

DD. Leaves non-glaucous, vernicose ..... *E. VERNICOSA*

CC. Umbels axillary in alternate leaves.

F. Average length of peduncles equal to or exceeding 13 mm.; fruit urceolate.

G. Average diameter of fruit equal to or less than 1 cm. ..... *E. URNIGERA* (7)

GG. Average diameter of fruit exceeding 1 cm. ..... *E. BIANGULARIS* (29)

FF. Average length of peduncles less than 13 mm.

H. Buds pedicellate, central pedicel, 1·5 mm. or longer, lateral pedicels rarely absent.

J. Valves sunk in capsule, slightly exsert or not exsert.

K. Tips of valves slightly to freely protruding. Always associated with *E. Dalrympleana* and *E. Gunnii* ..... *E. IRBYI* (3)

KK. Valves completly enclosed ..... *E. GUNNII* (12)

JJ. Valves not sunk in capsules.

L. Buds, fruits, mature leaves or branchlets with traces of glaucousness;[1] juvenile leaves strongly glaucous, sessile, ovate to orbicular or cordate, 2-6 x 2·5-5 cm. ..... *E. RUBIDA* (6)

[1] Examination for traces of glaucousness should not be made in artificial light.

LL. Glaucousness absent in adult stage.
M. Average length of peduncles usually exceeding 5 mm.; juvenile leaves sub-glaucous to glaucous, sessile, oblong-ovate to ovate or cordate, 4-6 x 4-5 cm. or larger; sometimes stem-clasping .... *E. DALRYMPLEANA* (24)

MM. Average length of peduncles 5 mm. or less; juvenile leaves not glaucous in the type, sessile, oblong to oblong-lanceolate, 5-10 x 1-3 cm. .... *E. VIMINALIS* (5)

HH. Buds sessile, or lateral buds sessile, with central pedicel equal to or less than 1·5 mm., or all buds with pedicels equal to or less than 1 mm.
N. Maximum diameter less than the altitude of the fruit.
O. Calyx tube obconical to sub-cylindrical, fruit sub-urceolate to urceolate, buds, fruits, and branchlets usually glaucous .... *E. DIVARICATA* (11)

OO. Calyx tube cylindrical or ovoid, fruit campanulate to ovoid-truncate, glaucousness absent in the adult stage .... *E. ARCHERI* (10)

NN. Maximum diameter equal to or exceeding the altitude of the fruit.
P. Mature leaves, buds, fruit, and branchlets usually strongly glaucous; juvenile leaves glaucous and perfoliate .... *E. PERRINIANA* (13)

PP. Glaucousness absent in adult stage: juvenile leaves non-perfoliate, non-glaucous or glaucous.
Q. Average ratio of length of mid-rib to maximum diameter of leaf less than 7·7; species confined to alpine or sub-alpine situations.
R. Average length of mature leaf blade exceeding 4·5 cm.
S. Average maximum diameter of mature fruit equal to or exceeding 9·5 mm. .... *E. JOHNSTONI* (25)

SS. Average maximum diameter of mature fruit less than 9·5 mm. .... *E. SUBCRENULATA* (8)

RR. Average length of mature leaf blade equal to or less than 4·5 cm. .... *E. VERNICOSA* (9)

QQ. Average ratio of mid-rid to maximum diameter of leaf equal to or exceeding 7·7; not found in alpine or sub-alpine situations, and always associated with *E. globulus* and *E. viminalis* *E. UNIALATA* (28)

SECTION II.—RENANTHERAE: Umbels, with the exception of the three-fruited *E. coccifera*, averaging more than three flowers.

A. Midrib bisecting the greatest width of the leaf or nearly so.

B. All or some leaves with semi-longitudinal venation.

C. Peduncles strap-shaped.

D. Average length of peduncles usually equal to or exceeding 12 mm., mature leaves vernicose; average maximum width of leaves usually equal to or exceeding 17 mm.; fruit pyriform to falcate-pyriform, pinnately veined leaves absent .... *E. SIEBERIANA* (17)

DD. Average length of peduncles usually less than 12 mm., mature leaves sub-vernicose; average maximum width of leaves less than 17 mm.; fruit sub-pyriform to ovoid-truncate, pinnately veined leaves often present; always in association with *E. Sieberiana* and *E. salicifolia* .... *E. TAENIOLA* (31)

CC. Peduncles terete to angled.

E. Average length of peduncles exceeding 8 mm., juvenile leaves opposite for three to five pairs, bark smooth to base *E. PAUCIFLORA* (22)

EE. Average length of peduncles equal to or less than 8 mm., juvenile leaves opposite for a large number of pairs; bark rough on the stem, upper branches smooth .... *E. SIMMONDSI* (26)

BB. Veins pinnate, a few at the base sometimes with a longitudinal tendency, or venation of mature leaves obscure.

F. Buds and fruit non-glaucous or with minute traces of glaucousness.

G. Average maximum width of the leaves less than 1·5 cm.

H. Average maximum width of the leaves equal to or exceeding 0·5 cm.; bark rough, upper branches often smooth, with bark hanging in ribbons (seedlings raised from occasional smooth barks in this class appear to indicate hybridization) .... *E. SALICIFOLIA* (18)

HH. Average maximum width of leaves less than 0·5 cm.; bark smooth to base .... *E. LINEARIS* (20)

GG. Average maximum width of leaves exceeding 1·5 cm. .... *E. TENUIRAMIS* (19)

FF. Buds or fruit, or both buds and fruit, sub-glaucous to strongly glaucous; buds smooth to costate or angled.

J. Umbels axillary in opposite leaves.

K. Alternate leaves absent from the tree; fruit pyriform-truncate; top of capsule sub-concave to concave .... *E. RISDONI* (21)

KK. Majority of leaves on adult tree alternate; fruit turbinate to sub-globose, or sub-pyriform to pyriform truncate; top of capsule convex to flat, or sub-concave to concave *E. TASMANICA* (27)

JJ. Umbels axillary in alternate leaves.
L. Buds sessile, tapering at the base in the larger fruited types to give effect of a peduncle; operculum flat or concave, without any well-defined point, or rarely sub-acute.
M. Umbels 3-6 flowers .... *E. COCCIFERA* (23)
MM. Some umbels with more than 6 flowers *E. TASMANICA* (27)
LL. Buds pedicellate; umbels 6-25 flowered; operculum more or less convex, acute, or obtuse, smooth or warty .... *E. TASMANICA* (27)
AA. Midrib not bisecting the greatest width of the leaf.
N. Fruit pyriform; disc oblique; valves not protruding, more or less deeply enclosed by the disc; average diameter of mature fruit exceeding 7 mm.
O. Glaucousness to sub-glaucousness present on buds, fruits, and mature leaves or branchlets; old fruit and branchlets pruinose; juvenile leaves glaucous, oblong-ovate to oblique lanceolate .... *E. GIGANTEA* (15)
OO. Glaucousness absent in the adult and juvenile stages; branchlets not pruinose, old fruit green or brown .... *E. OBLIQUA* (14)
NN. Fruit obconical to sub-pyriform; disc flat to sub-oblique, usually 1 mm or less in width; valves enclosed by the disc, and often slightly protruding; average maximum diameter of mature fruit 7 mm. or less .... *E. REGNANS* (16)

Check-List

The descriptions below are concerned not with the complete range of a species when that extends beyond the State, but only on the Tasmanian forms. The greatest assistance has been gained from 'A Key to the Eucalypts'. Eucalyptography owes a great debt to W. F. Blakely for this pioneer work. The form of the descriptions follows the excellent example set by Blakely; every measurement has been checked, and departures from the estimates and descriptions given in the above work have only been made when necessary. In some cases these are substantial, e.g., *E. rubida* is quoted as having sessile buds; Tasmanian forms are never sessile, whereas specimens of *E. rubida* collected by me in Victoria have umbels with completely sessile buds. Other important differences will be noted.

1. **E. ovata** Labill. (*E. acervula* Hook., f.). Labill., 1806—Nov. Holl. Pl. ii, 153. A medium to small tree, but sometimes up to 30 m. Bark usually rough at the base, but smooth deciduous on portion of trunk and upper limbs. White or brown in colour. Old isolated trees sometimes exhibit a black scaly bark persistent on whole of trunk. Juvenile leaves opposite for 4 or more pairs, ovate to orbicular, undulate, very shortly petiolate, 4-8 × 3-7 cms., glaucous

to green. Intermediate leaves alternate, ovate to ovate-lanceolate, with long petioles 11 × 5 cm. or larger. Mature leaves alternate-ovate to ovate-lanceolate, undulate, sometimes emarginate, subvernicose with long petioles, thinly to thickly coriaceous, venation clearly defined, 9-12 × 1·3-5 cm. Umbels axillary, 4-8 flowered. Peduncles terete to compressed, 5-12 mm. Buds pedicellate, elliptical with obconical calyx-tube, 8-9 mm. × 5-7 mm. Operculum pointed, subrostrate, equal or slightly greater in altitude than the calyx-tube. Fruit obconical, 5-9 × 6-8 mm. Valves exsert.

Habitat: Common at sea-level, where it is found growing in sandy and poor soil. It also thrives in swampy ground at an elevation, and in some northern districts is called 'Swamp Gum'.

Distribution: Common at sea-level and up to 2000 feet. Also Victoria, New South Wales, and South Australia. Marked differences are observable between *E. ovata* in Victoria and Tasmania. The South Australian trees match those of the Tasmanian distribution very well.

Affinities: With *E. aggregata.*

Hybrids: Hybridizes freely with *E. viminalis* and probably *E. salicifolia.* One hybrid with *E. globulus* has been investigated (see note to Group 3). The forms with glaucous juvenile foliage occasionally found may be due to hybridization with *E. pauciflora,* with which this species is sometimes associated in Midland districts.

2. **E. aggregata** Deane and Maiden (*E. Rodwayi* Baker and Smith). Deane and Maiden, 1900—Proc. Linn. Soc. N.S.W., XXV, 104. A medium to tall tree, up to 45 m. Bark rough, dark, fibrous, persistent to the secondary branches, suggesting that of a black peppermint (*E. salicifolia*), with which this species is confused by uncritical observers. Juvenile leaves opposite for 4 to 5 pairs, ovate to oblong, with reduced petioles 4-6 × 1·5-3·5 cm. Intermediate leaves ovate to narrow-lanceolate. Mature leaves alternate, petiolate, narrow-lanceolate to narrow-falcate-lanceolate, venation obscure when fresh, dark-green and shining, 7-12 × 1·5-2·3 cm. Umbels 4-8 flowered. Peduncles slender, 4-6 mm. Buds elliptical, shortly pedicellate, 3-4 × 4-5 mm. Operculum conical, equal to or slightly exceeding the calyx-tube. Fruit hemispherical, shortly pedicellate, 4 × 5 mm. Valves exsert.

Habitat: Prefers marshy land at an elevation.

Distribution: Tasmania—Victoria Valley, Interlaken, Penstock Lagoon, Guildford Junction. Also New South Wales.

Affinities: With *E. ovata.*

Hybrids: The black fibrous bark of the tree is a constant character, and the infrequent smooth barks are found in a mixed stand of *E. pauciflora* and *E. aggregata.* Occasional seedlings of these trees have a tendency to glaucousness, suggesting hybridization with *E. pauciflora.*

3. **E. globulus** Labill. Labillardière, 1799—Relation du Voyage Recherche Perouse, 1, 153. A small to large tree, depending mainly on type of soil conditions, 6-45 m. Bark smooth, deciduous, sometimes rough and deeply furrowed on the whole or half the trunk, olive-green to reddish-brown. Juvenile leaves opposite for an indefinite number of pairs, sessile to amplexicaul, glaucous, oblong-ovate to oblong-lanceolate, 7-16 × 4-9 cm. The non-glaucous juvenile leaves occasionally found on Mt. Wellington, and perhaps elsewhere, are probably due to hybridization with *E. viminalis* or even *E. ovata*. Intermediate leaves petiolate, alternate broad-lanceolate to ovate-lanceolate and falcate-lanceolate. Mature leaves alternate, petiolate, dark-green, subvernicose to vernicose, lanceolate to falcate-lanceolate, 10-30 × 3-4 cm. or larger. Umbels axillary, usually 1-flowered, sessile. Terminal umbels are occasionally 3-flowered, and rare trees have a majority of 3-flowered umbels. A polymorphic hybrid swarm connects *E. globulus* with *E. viminalis*, and it is possible that these 3-fruited forms are components. A specimen showing *E. globulus* budding in the opposite-leaved stage, collected by Mr. E. Cruickshank from the stump of a felled tree at Glenorchy, is preserved in the Rodway Herbarium. Peduncles much reduced, compressed, broad or triangular. Buds glaucous, turbinate, rugose, quadrangular, 20-30 × 20 mm. Operculum calyptriform, umbonate, rugose, shorter than the calyx-tube. Fruit sessile, depressed globular to turbinate, rugose, quadricostate, 10-20 × 15-30 mm. Disc large, convex, thick, smooth, sometimes covering valves which are slightly exsert.

Habitat: Prefers moist, well-drained, sandy soil in sheltered valleys, and in these conditions grows to a tall timber tree. When growing on dry mudstone hills it is reduced almost to shrub-like dimensions, and acquires a mallee habit. Will flourish in sandy soil at sea-level.

Distribution: Blakely (1934) does not give any mainland localities for *E. globulus*. I am informed by Mr. St. John, of the National Herbarium, Melbourne, that *E. globulus* with single fruits in the umbel grows in Victoria. I have not seen these trees in the field. Both from field observation and evidence from seed-raising I am fully convinced that *E. St. Johnii* R. T. Baker and *E. bicostata* Maiden Blakely and Simmonds, included as varieties of *E. globulus* in Flora of Victoria (Ewart, 1930), although allied to *E. globulus*, are specifically distinct from it.

Tasmania: Common on East and South-East Coast, Risdon, Mt. Wellington, Spring Hill.

Affinities: With *E. Johnstoni*.

Hybrids: With *E. viminalis, E. ovata, E. urnigera*.

4. **E. cordata** Labill. Labillardière, 1806—Nov. Holl., Pl. ii, 13, t. 152. A small shrub to tall tree, 1·2-60 m. In this connection the following quotation from the Crit. Rev. (Maiden), Pt. 51, Vol. VI, is important: 'Mr. L. Rodway, of Hobart, writes to me that at Cape Frederick Henry, Brown Mt., and Ridgeway it is a scrambling

to semi-erect shrub of about 4 or 5 feet. In the South-West Gully at Chimney Pot Hill, close to Ridgeway, it is a small tree up to, say, 20 feet in height. At Uxbridge he has seen trees of it approximately 100 feet, and Mr. Fenton, of that town, an experienced timber-cutter, brought him a specimen in typical foliage and flower from a tree that was 200 feet high, with a clean branchless bole for 100 feet, and with timber light yellow ochre in colour'. I have seen the Uxbridge specimens in the Rodway Herbarium, and they are without a doubt close to the type. Further observations and research are necessary with this species. Bark smooth, white, with green to purplish blotches. Juvenile leaves opposite for an indefinite number of pairs, cordate to cordate or even oblong-lanceolate, crenulate, sessile, amplexicaul, glaucous. Intermediate foliage similar to the juvenile. Mature leaves opposite, sessile to amplexicaul, cordate to ovate-lanceolate. Umbels axillary, 3-flowered. Peduncles 5-10 mm. Buds sessile, turbinate to depressed-urceolate. Operculum calyptriform, umbonate to subapiculate, shorter than the calyx-tube. Fruit sessile, glaucous, ovate-truncate to globular. Valves 3-4, deeply enclosed.

Habitat: More information is necessary (see note above on size of tree). I am not as yet able to say that the small scrambling shrubs at Brown Mt. will give seedlings that grow to tree dimensions under favourable conditions. A medium tree growing in a Hobart garden is said to be raised from seed collected at Chimney Pot Hill, Mt. Wellington.

Distribution: Confined to Tasmania. Mt. Wellington, Brown Mt., Port Arthur, Nelson's Tier, Recherche Bay.

Affinities: With *E. urnigera.*

Hybrids: With *E. globulus.*

5. **E. viminalis** Labill. Labillardière, 1806—Nov. Holl., Pl. ii, 12, t. 151. A small to medium tree, 6-15 m. Bark smooth, white, deciduous, or scaly rough at base, occasional trees with a more or less deeply furrowed bark to upper branches. Juvenile leaves opposite for an indefinite number of pairs, dark to light green, glossy in the comparatively pure types, sessile to amplexicaul, 5-10 × 1-3 cm. or larger. Intermediate leaves petiolate, alternate, broadly-lanceolate to falcate. Mature leaves alternate, lanceolate, lanceolate to falcate-lanceolate, 11-18 × 1·5-2 cm. Umbels axillary, 3-flowered. Peduncles terete, 3-6 mm. Buds with short to well-developed pedicels, ovoid to cylindroid, 5-7 × 4-5 mm. Operculum obtuse to acute, hemispherical to conical, as long as or shortly longer than the calyx-tube. Fruit pedicellate, spherical to turbinate, 5-6 × 7-8 mm. Disc prominent, subconvex to convex. Valves 3-4, strongly exsert.

Habitat: Will thrive in sandy or clay soils, but prefers well-drained moist conditions in sheltered valleys.

Distribution: Tasmania. Common except in south and west.

Affinities: With *E. rubida* and *E. Dalrympleana.*

Hybrids: With *E. rubida, E. ovata, E. globulus,* and *E. salicifolia.*

A polymorphic hybrid swarm connects *E. globulus* and *E. viminalis.* Some of these components with normal *viminalis* fruits produce juvenile foliage of normal dimensions, but strongly to faintly glaucous, others have sub-glaucous, broad ovate-lanceolate leaves (see Plate XV, fig. 3). Some of these which are comparatively common on Mt. Wellington have been confused with *E. Dalrympleana.* A specimen in the Rodway Herbarium from Mt. Nelson, labelled *E. Dalrympleana* by Maiden, matches the foliage shown in Plate XV, fig. 3. Such specimens as these probably explain the mention of Chimney Pot Hill by Blakely in 'Key to Eucalypts' as a locality for *E. Dalrympleana.*

Also the existence of occasional rough barked trees of *E. viminalis,* to be seen at Lindisfarne and elsewhere, probably explains the reference to *E. Huberiana* Naudin for Tasmania in the same volume. I am well acquainted with *E. Huberiana* in South Australia and Victoria, and believe it to be similar to those species in Group 2, i.e., it consists of many hybrid races in various stages of stability. Seedlings raised from these different forms exhibit marked differences almost from the cotyledon stage. Examination of *E. viminalis* in the Lofty Range, South Australia, and in Victoria and Tasmania, suggests that the biotype is smooth-barked and 3-fruited. The many-fruited, smooth-barked forms do not produce more or less pure stands as do the rough-barked races at present called *E. Huberiana.* Occasional smooth-barked, many-fruited forms are found in Tasmania. The origin of these is most probably hybridization with *E. ovata*; the many-fruited character is not present in every umbel. A large proportion of the umbels carry the typical cruciform arrangement of three buds. Smooth-barked hybrids with *E. salicifolia* (quite distinct from *E. linearis* and the occasional deciduous or semideciduous forms found in a pure stand of *E. salicifolia*) are often present where these two species meet, as at Westerway.

6. **E. rubida** Deane and Maiden. Deane and Maiden, 1899—Proc. Linn. Soc. N.S.W., xxi, 156. A very glaucous small to tall tree, 9-30 m. Bark smooth, white, often blotched pink or red. Juvenile leaves opposite for an indefinite number of pairs, glaucous, sessile, cordate to orbicular or ovate, 2-6 × 2·5-5 cm. Intermediate leaves petiolate, glaucous, ovate to ovate-lanceolate, short-lanceolate to falcate-lanceolate. Mature leaves alternate, petiolate, lanceolate to falcate-lanceolate subvernicose, 10-18 × 2-3·5 cm. Branchlets bear a fine glaucous bloom. Umbels axillary, 3-flowered. Peduncles subterete, 3-6 mm. Buds glaucous or subglaucous, ovoid, 6-7 × 4-5

mm., shortly to distinctly pedicellate. Operculum conical to hemispherical, equal to calyx-tube. Fruit pedicellate, subglaucous to glaucous, 4-6 × 4-8 mm., hemispherical to turbinate. Disc flat to domed. Valves exsert.

Habitat: Prefers open country at an altitude of 1000 to 2000 feet. Thrives on poor soils of mudstone varieties.

Distribution: Tasmania. Westerway, Ouse, Conara, St. Marys. Also South Australia, Victoria, New South Wales, Queensland.

Affinities: With *E. viminalis* and *E. Dalrympleana.*

Hybrids: With *E. Dalrympleana* where the two species meet. A wide variability in size of fruit can be seen from measurements above. Seedlings raised from a tree of the small-fruited type exhibit a wide range of variability in juvenile leaves, both in colour and shape. Some have practically normal shape, but are dark glossy green. It is not yet possible to say whether the small fruit is associated with the hybrid character.

An observer of *E. rubida* in South Australia, Victoria, and Tasmania might incline to the view that the most 'typical' *E. rubida* is in Tasmania. In the first mentioned State a high degree of hybridization has taken place. It is safe to assume that the multiflowered *E. rubida* is of hybrid origin. I have in my possession seedlings from such a tree growing at Woodside, South Australia. Almost perfect segregation towards *E. camaldulensis* Dehn. (*E. rostrata* Schlecht) and *E. rubida* is shown.

7. **E. urnigera** Hook., f. Hooker, f., 1847—Lond. Journ. Bot., Part VI, 477. A small to medium tree, with drooping branches, 9-12 m. Bark smooth, deciduous, white, blotched green and red. Juvenile leaves opposite for an indefinite number of pairs, strongly glaucous in type, cordate, orbicular to elliptical or ovate, sessile to shortly petiolate, crenulate, 6 × 7 cm. or larger. These leaves bear a striking resemblance to the mature leaves of *E. cordata.* Mature leaves alternate, petiolate, green, narrow to broad-lanceolate, 8-18 × 1·7-2·5 cm. Umbels axillary, 3-flowered. Peduncles compressed to subterete, 13-20 mm. Buds urceolate, petiolate, glaucous, 12-14 × 7 mm. Non-glaucous buds and fruit departing from these rough limits of measurement are most probably hybrids of *E. Johnstoni,* or represent a comparatively stabilized race with glossy, dark-green, juvenile foliage, probably derived by hybridization from *E. Johnstoni,* and confined to Mt. Wellington. (See note under *E. Johnstoni.*) Operculum umbonate or subapiculate, forming a cap to the calyx-tube, and much shorter than it. Fruit pedicellate, urceolate, 15-17 × 7-10 mm. Valves deeply enclosed.

Habitat: Prefers well-drained situations at sub-alpine levels.

Distribution: Confined to Tasmania. Mt. Wellington and common on the Central Plateau.

Affinities: With *E. divaricata.*

Hybrids: With *E. Johnstoni*, also probably *E. Dalrympleana*, and *E. subcrenulata.*

The following extract from the Crit. Rev. (Maiden) refers to the variety *E. elongata* of Rodway: 'A tall, spreading tree. Bark smooth, white. Leaves linear-lanceolate, 4-8 inches long. Peduncles not very long. Operculum conical umbonate, half as long as the capsule. Fruit pyriform-globose, slightly constricted, ½-inch long. Capsule much sunk. ('The Tas. Flora', p. 58.)

Mr. Rodway (in a letter to me) points out the close resemblance of the juvenile foliage of this form to that of *E. viminalis.* He has suggested the possibility of this form being a hybrid between *E. urnigera* and *E. viminalis,* and says that wherever he has seen the variety growing, he has always seen the two species associated'.

Insufficient note has been taken in the past of Rodway's field observations of this type. In my experience his opinions on natural hybrids of *Eucalyptus* have always been most reliable.

8. E. subcrenulata Maiden and Blakely. Maiden, 1929—Crit. Rev., Part LXXI, 59. A small alpine tree to large timber tree, up to 60 m., with a smooth deciduous bark of brilliant orange when freshly exposed. Juvenile leaves opposite for an indefinite number of pairs, dark glossy green, sessile, orbicular to ovate, subcrenulate and undulate. Intermediate leaves alternate, petiolate, broadly ovate to oblong-lanceolate, subcrenulate, dark-green, vernicose, 5-10 × 3-5 cm. Mature leaves alternate, with long subterete petioles, oblong to oblong-lanceolate and narrow falcate-lanceolate, coriaceous, subcrenulate, 5-12 × 1·5-2·5 cm., dark-green and vernicose. All leaves change colour to light-green on drying. Umbels axillary, 3-flowered. Peduncles 2-4 mm. or longer. Buds sessile, ovoid to globular, compressed at the base, 6-8 × 5-6 mm., irregularly ribbed or faintly winged to smooth, pitted rugose; operculum conical, obtuse to subrostrate, usually shorter than the calyx-tube. Fruit hemispherical to shortly campanulate. Valves strongly exsert.

The type description as published by Blakely (1934) is misleading, as it was probably described on insufficient material. It is there regarded as a small alpine tree. This tree, which is very common on the Central Plateau, was previously thought to be *E. Johnstoni.* On a collecting trip to National Park, Prof. A. L. McAulay concluded that this form of *E. Johnstoni,* as then regarded, is identical with *E. subcrenulata,* and later, on Biological Survey work in the same district, considered that the reduced alpine forms are identical with the tall timber tree below Lake Fenton, also previously regarded as *E. Johnstoni.* In these opinions I concur, and have shown from a rough statistical examination that the group of forms under the name of *E. Johnstoni* at present confined to Mt. Wellington is distinct from *E. subcrenulata.* The reduced alpine forms of this species are undoubtedly the forms showing transit to *E. vernicosa* described by Rodway and others.

Habitat: Alpine and sub-alpine situations. In sheltered situations the tree thrives and grows to large dimensions.

Distribution: Confined to Tasmania. Common on the Central Plateau, extending north to Cradle Mt.

Affinities: With *E. vernicosa* and *E. Johnstoni.*

Hybrids: With *E. Gunnii.*

9. **E. vernicosa** Hook., f. Hooker, f., 1847—Lond. Journ. Bot., VI., 478. A shrub or small tree, often of twisted appearance, 1·2-3·6 m. Bark smooth, deciduous, brown-orange. Juvenile leaves dark-green, glossy, opposite for an indefinite number of pairs, sessile or shortly petiolate, elliptical to oblong or oblong-lanceolate, 1·5-2 × 1-2 cm. Intermediate leaves similar to juvenile, but with developed petioles. Mature leaves opposite or alternate, elliptical to lanceolate, petiolate, subcrenulate, dark-green, strongly vernicose and thick, 1·5-5 × 1·5-2 cm Umbels axillary, 1-3 flowered. Peduncles thick, 1·5-5 mm. Buds sessile, elliptical, 7-8 × 5 mm. Operculum hemispherical, apiculate or sharply conical, equal to or shorter than the slightly ribbed calyx-tube. Fruit sessile, hemispherical to shortly campanulate or subcylindrical, 5-7 × 7-8 mm. Valves 3-5, enclosed.

Habitat: Alpine situations.

Distribution: Confined to Tasmania. Mt. Fatigue, Mt. La Perouse to Arrowsmith, West Coast, Mt. Sorell, Macquarie Harbour, Cradle Mt.

Affinities: With *E. subcrenulata* and *E. Johnstoni.*

Hybrids: Trees growing on the shores of Sutton's Tarn in the Cradle Mt. Reserve strongly suggest hybridization with *E. subcrenulata.* A study of material collected over a wide area appears to indicate two biotypes: a single-fruited form, common in the south-west, and a 3-fruited form. The Cradle Mt. trees are exclusively of the latter. It is tentatively suggested that this latter may have arisen from hybridization with *E. subcrenulata.* Further field and horticultural observation is necessary on this point.

10. **E. Archeri** Maiden and Blakely. Maiden, 1929—Crit. Rev., Part LXXI, 58. A small shrub or dwarf stunted to medium tree, 3-9 m. Bark smooth, deciduous, orange in colour, sometimes scaly at base. Juvenile leaves glaucous, opposite for an indefinite number of pairs, sessile to shortly petiolate, cordate to orbicular or elliptical. Intermediate leaves elliptical to oblong-lanceolate or spathulate. Mature leaves alternate, coriaceous, narrow-lanceolate to broad-lanceolate and falcate-lanceolate, 5-10 × 1-3 cm. Umbels axillary, 3-flowered. Peduncles compressed, 3-7 mm. Buds sessile or nearly so, oblong or cylindrical, 5 × 6 mm. Operculum hemispherical, obtuse, 2-3 times shorter than the calyx-tube. Fruit, sessile, ovoid-truncate to campanulate, 6-7 × 5-6 mm. Valves deeply sunk, with tips minutely emerging at times.

Habitat: An alpine to sub-alpine species.

Distribution: Confined to Tasmania. Western Tiers and Mt. Barrow. The type specimen which, through the kindness of Mr. Blakely, I have been able to see is given as from the Western Mts. Doubtless this means the Western Tiers. Material collected from this locality matches the type very well.

Affinities: With *E. Gunnii* and *E. divaricata.*

Hybrids: There is a specimen in the Rodway Herbarium, labelled *E. Gunnii,* from the Western Tiers. A pencil note of the collector calls attention to the strong resemblance of the buds to those of *E. viminalis.* These would certainly pass for buds of *E. viminalis,* if separated from the fruit. The pedicels are up to 2 mm. in length, while fruit and leaves are close to the type of *E. Archeri.* The specimen certainly suggests a hybrid of possibly *E. Dalrympleana.*

11. E. divaricata McAulay and Brett, sp. nov. (Plate XVII.) Arbor divaricata, alta 12-15 m.; cortice squameo; ramulis tenus persistente, cinereo, v. nigro. Folia juvenilia bina opposita per multa paria, cordato-orbiculata v. elliptica, sessilia vel. brevi-petiolata, 2·5 cm. longa, 2 cm. lata. Folia intermedia alterna, petiolata, elliptica v. oblongo-lanceolata. Folia matura glauca v. atroviridia, alterna, angusto v. lato-lanceolata, v. falcato-lanceolata, 4-8 cm. longa, 1·5-3 cms. lata. Umbellae axillares, 3-florae, pedunculis compressis v. sub-compressis, 5-10 mm. longis. Gemmae sessiles v. brevi-pedicellatae, glaucae, obovatae v. cylindriformes, 6-8 cm. longa, 5 mm. lata. Operculum plano-hemisphaericum v. planum v. calyptriformem, subapiculatum, brevius quam calycis tubo. Capsulae, glaucae, cylindriformes v. suburceolatae, 7-9 mm. longae, 6 mm. latae. Valvae inclusae.

A small to medium umbrageous tree, with markedly divaricating branches, 12-15 m. Bark rough, scaly, grey to black, persistent on the trunk and branches; the branchlets covered with a light to heavy glaucous bloom. Juvenile leaves opposite for an indefinite number of pairs, glaucous, cordate orbicular to elliptical, sub-crenulate, sessile to shortly petiolate, 2·5 × 2 cm. In a general way the juvenile leaves of *E. Gunnii* are larger than those of *E. divaricata* and *E. Archeri,* whilst the glaucousness of the juvenile *E. divaricata* is more marked than that of either of the other two. Intermediate leaves alternate, petiolate, elliptical to oblong-lanceolate or lanceolate. Mature leaves green, alternate, petiolate, narrow to broad-lanceolate or falcate-lanceolate, 4-8 × 1·5-3 cm. Umbels axillary, 3-flowered. Peduncles compressed to almost terete, 5-10 mm. Buds sessile to shortly pedicellate, glaucous, obovate to cylindroid, 6-8 × 5 mm. Operculum depressed, hemispherical or flat to cap-shaped, sub-apiculate, shorter than the calyx-tube. Fruit glaucous, cylindroid to sub-urceolate, often urceolate when immature, 7-9 × 6 mm. Disc small, slightly convex, valves deeply sunk.

Habitat: A sub-alpine species; prefers open flats at an altitude of about 3000 feet.

Distribution: Northern and eastern shores of the Great Lake, Miena, skirting St. Patrick's Plains, Arthur Lakes. Confined to Tasmania.

Affinities: With *E. Gunnii, E. Archeri,* and *E. urnigera.*

Hybrids: With *E. Dalrympleana.* There are many hybrids of these two species on Alma Tier. The trees resemble *E. Gunnii* in their smooth barks and pedicellate buds. The juvenile foliage of the seedlings is very distinct from that of juvenile *E. divaricata.* It is much larger and less glaucous.

12. **E. Gunnii** Hook., f. Hooker, J. D., 1844—Lond. Journ. Bot., iii, 499. A medium to tall tree, up to 30 m. Bark smooth, deciduous, scaly, persistent at base of old trees, orange to pinkish-white. Juvenile leaves opposite for an indefinite number of pairs, glaucous, cordate, orbicular to elliptical, sessile to shortly petiolate, 3-4 × 2-4 cm. or larger. Intermediate leaves alternate, elliptical to oblong-lanceolate, green to glaucous, crenulate. Mature leaves alternate, narrow to broad-lanceolate, 4-7 × 1·5-3 cm. Umbels axillary, 3-flowered. Peduncles compressed to terete, 3-8 mm. long. Buds sub-glaucous to non-glaucous, pedicellate, cylindroid, with an umbonate or mucronate operculum less than the calyx-tube. Fruit shortly pedicellate to nearly sessile, hemispherical or campanulate to ovoid-truncate, 7-10 × 5-8 mm. Valves sunk in capsule, not exsert.

Habitat: A sub-alpine tree, preferring marshy conditions.

Distribution: This tree has been reported both in Victoria and New South Wales. I have not seen the specimens from the summit of Mt. Baw Baw, Victoria, but have raised plants from seed labelled *E. Gunnii* collected in New South Wales. The seedlings bear no resemblance to those of *E. Gunnii.* I believe, with R. T. Baker (1912), that this species is confined to Tasmania.

Tasmania: The Middlesex Plain, Alma Tier, Mt. Arrowsmith.

Affinities: With *E. Archeri* and *E. divaricata.*

Hybrids: With *E. Dalrympleana* (Baker's Tier) and *E. subcrenulata* (Cradle Mt. Reserve).

The following two specimens in the Rodway Herbarium strongly suggest natural hybridization with *E. subcrenulata.* Both were collected on Mt. Field (whether East or West is not stated). In this area the two species form an association.

Specimen I, labelled *E. Gunnii* H. Mt. Field, 1902: The buds are large, and resemble those of *E. Gunnii,* but peduncles are long, equal to or exceeding 8 mm. The fruit is that of *E. subcrenulata.* The sucker foliage would match that of *E. urnigera.*

Specimen II, labelled *E. Gunnii,* cultivated in Hobart from seed collected on Mt. Field: Only buds appear, and all parts are more highly glaucous, but there are strong resemblances, particularly in long peduncles, to Specimen I.

13. **E. Perriniana** (F. v. M.) Rodway. Rodway, 1893—Pap. Roy. Soc. Tas., 181. A small, shrub-like tree of mallee habit to medium tree, about 3-12 m. Bark smooth, deciduous, of glaucous appearance, with pruinose blotches, sometimes scaly at base. The mature tree presents a glaucous pruinose appearance. Juvenile leaves opposite for an indefinite number of pairs, glaucous, perfoliate, orbicular to elliptical-cordate, 5-6 × 4-10 cm. Intermediate leaves glaucous, ovate, connate at base or opposite and sessile, or alternate, lanceolate or falcate-lanceolate, petiolate. Mature leaves glaucous, petiolate, alternate, lanceolate to falcate-lanceolate, up to 13 × 1-2·5 cm. Old trees may exhibit all three types of foliage on the one secondary branch. Umbels axillary, 3-flowered. Peduncles 2-5 mm. Buds glaucous, sessile, with central pedicel sometimes developed, 6-9 × 4-7 mm. Fruit glaucous, sessile, truncate-globose to subcylindrical, 5 × 7-8 mm. Valves 4-5, completely enclosed or minutely exsert.

Habitat: Prefers poor soil of the mudstone variety at an elevation.

Distribution: Tasmania (Tunnack, Strickland); also Victoria and New South Wales.

Affinities: Possibly with *E. Gunnii.*

Hybrids: None observed.

14. **E. obliqua** L'Herit. L'Heritier, 1788—Sert. Angl., p. 18, t. 20. A medium to tall tree, 15-60 m. Bark fibrous, deeply furrowed, and persistent to branchlets, occasionally smooth, deciduous on branches. Juvenile leaves opposite for 3-4 pairs, petiolate, lanceolate to elliptical-lanceolate, 6-8 × 3-4 cm. Intermediate leaves alternate, obliquely ovate to lanceolate, bright green or yellowish-green and shining, up to 20 × 14 cm. or larger. Mature leaves alternate, petiolate, oblique-lanceolate, 10-16 × 2-3 cm., thick and shining. Umbels axillary, 7-16 flowered. Peduncles compressed to subterete, 8-13 mm. Buds clavate, pedicellate, 7 × 3-5 mm. Operculum hemispherical, smooth or apiculate, shorter than the calyx-tube. Fruit pyriform, truncate, pedicellate, 8-12 × 8-10. Disc oblique. Valves deeply enclosed.

Habitat: Grows from sea-level to a moderate altitude. Thrives best in well-drained sandstone soils in sheltered valleys.

Distribution: Common in Tasmania. Also South Australia, Victoria, and New South Wales.

Affinities: With *E. regnans* and *E. Sieberiana.*

Hybrids: With *E. regnans* on Mt. Wellington; ×*E. Risdelata* on Tasman's Peninsula; also possibly with ×*E. Risdosalicilata* on Mt. Wellington, as smooth-barked types can be found with fruit-bearing, broad, flat discs, quite unlike the pyriform, obliquely rimmed fruit of *E. obliqua.*

15. **E. gigantea** Hook., f. Hooker, J. D., 1847—Lond. Journ. Bot., VI, 479; also 1860—Flora Tas., i, 136 (*partim*). A tall tree, 18-30 m. The smaller trees are possibly of hybrid origin. Bark rough, fibrous, deeply furrowed, persistent, grey in colour, extending for variable distances up the trunk; occasional trees bear strips of smooth bark to the base or are almost entirely smooth-barked (see note under hybrids). The smooth deciduous portions cream in colour, streaked with grey. The foliage tree presents a sub-glaucous appearance which is very characteristic. The sapling is markedly glaucous both on leaves and trunk. Occasional trees, as on Alma Tier, develop a marked weeping habit, with long pendulous branches of striking appearance. Juvenile leaves opposite for 3-4 pairs, petiolate, glaucous, lanceolate. Intermediate leaves alternate, oblong-elliptical to oblique-lanceolate, glaucous. Mature leaves alternate, petiolate, sub-glaucous, narrow-lanceolate to broadly oblique-lanceolate, 8-16 × 2-5 cm.; the branchlets covered with fine to heavy glaucous foliage. Umbels axillary, 7-15 flowered. Peduncles flattened to terete, 10-20 mm. or even longer. Buds clavate, pedicellate, faintly glaucous, 7-8 × 4-7 mm. Operculum hemispherical, obtuse or minutely umbonate, shorter than the calyx-tube. Fruit pedicellate, pyriform to globose-pyriform or falcate-pyriform, 10-14 × 9-13 mm. Disc thin, oblique to suboblique; valves enclosed.

Habitat: Prefers an altitude of 2000-3000 feet.

Distribution: Common in Tasmania, forming forests at an altitude from 2000-3000 feet. Also Victoria and New South Wales.

Affinities: With *E. obliqua* and *E. Sieberiana*.

Hybrids: With *E. obliqua*. On Mt. Wellington, small to medium trees, with practically smooth bark, shining mature leaves, and smaller fruits than the forest tree, suggest hybridization with *E. regnans* at the levels where the two trees are closely associated. In districts where the species associates with *E. Dalrympleana*, trees bearing smooth bark almost to the base are frequently found. The rough portions of the bark are scaly rather than fibrous, and the timber, according to Mr. L. Connell, of 'Waldheim', Cradle Mt., is of very inferior quality to that of the typical gum-top stringybark. The fruit is globose to sub-pyriform, with a broad convex rim, reminiscent of *E. Dalrympleana*.

16. **E. regnans** F. v. M. F. von Mueller, 1870—Rept. Accl. Soc. Vict., 20. A medium to very tall tree, 12-90 m. or taller. Some very tall trees of this species beyond the above limits have been reported in Southern Tasmania, but in the absence of absolutely reliable estimates no measurements are quoted. Bark smooth, deciduous on trunk and limbs, often peeling in long ribbons, occasionally persistent. The colour when freshly exposed is bluish-grey, occasionally streaked with cream. Juvenile leaves opposite for 2-3 pairs, shortly petiolate, lanceolate. Intermediate leaves petiolate, broad-lanceolate

to oblique-lanceolate, alternate. Mature leaves subvernicose, alternate, petiolate, narrow to broad oblique-lanceolate, acuminate, 10-16 × 2-5 cm. Venation with a semilongitudinal tendency. Umbels axillary, sometimes in pairs, 7-15 flowered. Peduncles terete, 8-15 mm. Buds clavate, pedicellate, 7-9 × 5 mm. Operculum hemispherical to conoid, shorter than the calyx-tube. Fruit pedicellate, obconical to campanulate, 7-8 × 5-6 mm. Disc flat to sub-oblique. Valves enclosed.

Habitat: Prefers moist, well-drained soil near running water. Forms stands at sea-level, but prefers rain forest conditions, and attains large dimensions in mountain gullies.

Distribution: Common up to an altitude of about 2000 feet. Also Victoria.

Affinities: With *E. obliqua.* Regarded by Mueller as having an affinity with *E. salicifolia*, but almost every character for comparison in Eucalypts separates the two trees.

Hybrids: With *E. obliqua*, and possibly *E. gigantea.*

17. **E. Sieberina** F. v. M. F. von Mueller, 1879—Eucalyptographia, Dec., ii. A medium to tall tree, 15-30 m. Bark rough, deeply furrowed, dark-grey, persistent on trunk; upper branches with smooth deciduous bark, cream in colour when freshly exposed. The branchlets and stem of saplings markedly glaucous. Juvenile leaves opposite for 4 to 5 pairs, sessile to shortly petiolate, elliptical to broadly lanceolate, glaucous, coriaceous, 8-12 × 5-7 cm. Intermediate leaves alternate, petiolate, glaucous, broadly lanceolate to sub-oblique-falcate-lanceolate. Mature leaves alternate, petiolate, lanceolate to falcate-lanceolate, vernicose, with semilongitudinal venation, 9-18 × 1·5-2 cm. Umbels axillary, 5-12 flowered. Peduncles strap-shaped, 7-14 mm. or longer. Buds clavate, pedicellate, 5-7 × 3-5 mm. Operculum hemispherical, shorter than the calyx-tube. Fruit pedicellate, pyriform-truncate, 8-11 × 7-8 mm.; disc small, flat or oblique; valves enclosed.

Habitat: Prefers coastal belts of sandy soil or valleys at a moderate altitude.

Distribution: Tasmania—Occupies a coast belt on the North-East Coast, Falmouth, George's Bay, St. Mary's Pass, &c. Also Victoria and New South Wales.

Affinities: With *E. gigantea* and to some extent *E. obliqua.*

Hybrids: With *E. salicifolia.* A polymorphic hybrid swarm connects *E. salicifolia* and *E. Sieberiana* where the two species are mixed. Also with *E. obliqua.* The *obliqua* hybrids have markedly oblique-lanceolate leaves.

18. **E. salicifolia** (Sol.) Cav. (*E. amygdalina* Labill.) Cav., 1797—Ic., iv, 24. A shrub to medium tree, depending on soil conditions and situation, 3-15 m. Bark fibrous, grey, persistent on the trunk

and branches. Often deciduous on the branches, and an occasional tree in a stand will present smooth bark to the butt. (Such a tree is quite distinct from *E. linearis*.) Juvenile leaves opposite for an indefinite number of pairs, linear to narrow-lanceolate, pale-green or glaucous, 0·7-1·5 cm. Intermediate leaves alternate, petiolate, lanceolate to falcate-lanceolate. Mature leaves petiolate, alternate, narrow-lanceolate to linear-lanceolate and linear-falcate, 4-10 × 0·7-1 cm. Umbels axillary, 5-12 flowered. Peduncles terete, 5-10 mm. Buds clavate, pedicellate, 4 × 3 mm. Operculum hemispherical, obtuse, shorter than the calyx-tube. Fruits pedicellate, hemispherical to sub-globose, 5 × 7 mm. Disc flat or sub-convex. Valves enclosed or slightly exsert.

Habitat: Prefers open country and sandstone soils. Extends from sea-level to an altitude of 3000 feet or even higher.

Distribution: Widely distributed throughout Tasmania, and is confined to the State.

Hybrids: E. salicifolia, particularly at sea-level, is a very distinct biotype, and forms pure stands, often of considerable extent. Many hybrid races of varying degrees of fixation make this species at times somewhat bewildering. The principal hybridization has probably occurred with *E. viminalis* (see note on hybrids of *E. viminalis*), *E. ovata* and × *E. Risdelata*. It is possible to note the influence of the last mentioned in the sucker foliage that follows destruction of a small stand by fire. Numerous instances of this occur in Southern Tasmania, e.g., about one mile from Huonville on the Hobart side. Tall, smooth-barked trees can be found with broad leaves where this species associates wih *E. viminalis* and *E. ovata*. A notable example of this occurs on Tunnel Hill, Cambridge.

Affinities: With *E. linearis*.

19. **E. tenuiramis** Miq. Miquel, 1856—Ned. Kruidk. Arch., iv, 128. An imperfectly investigated species for Tasmanian distribution. Isolated trees at Risdon in *E. Risdoni; E. salicifolia* associations possess characters intermediate between the two species. Specimens of these were collected by Prof. A. L. McAulay, who showed that they matched the description in 'Key to the Eucalypts' (Blakely), p. 414. It was thought that they might be hybrids of the above-mentioned species. This suggestion has been justified, since seedlings show perfect segregation, and approach very closely to both the supposed parents. The specimens noted from Recherche Bay and Grass Tree Hill (*loc. cit.*) are probably of the same character. Material collected recently near Moina, from a group of trees with what appeared to be normal variation, matches very well material sent from Flinders Island. The venation, width of leaves, and other characters suggest *E. tenuiramis*, but until seedlings are raised it is not possible to label this material with any certainty.

The position appears to be roughly as follows:

(1) There are trees on Flinders Island, and possibly other Straits Islands, which may justify separation from *E. salicifolia* as a species *E. tenuiramis.*

(2) Most of, it not all, the material collected on the mainland of Tasmania, and labelled *E. tenuiramis*, is of hybrid origin, probably from *E. Risdoni.*

It remains, then, to investigate more fully the Straits Islands peppermint, and determine whether it forms any pure stands on the mainland of Tasmania.

The following description is quoted from 'Key to the Eucalypts':

'A small to fairly tall tree, with a little rough persistent bark on the branches. Mature leaves alternate, petiolate, oblong-lanceolate to falcate-lanceolate, shortly apiculate or acuminate, thinly coriaceous and somewhat glossy on both sides, 5-11 × 1-2·5 cm., the venation sub-obscure, the lateral veins irregular, and sometimes one or two near the base semilongitudinal, thin, diverging at an angle of 10-25 deg. to the somewhat prominent midrib; intra-marginal vein remote from the thin margin. Umbels axillary, 5-20 flowered; peduncles almost terete, 5-8 mm. long. Buds pedicellate, clavate, shining, sub-angular at the base, 5 × 4 mm. Operculum patelliform, thick, shorter than the calyx-tube. Filaments all fertile; anthers reniform, very small. Fruit sub-pyriform to ovoid-truncate, somewhat thin, 3-4 celled, 8 × 5 mm., the disc oblique or flat and scarcely exceeding the calycine ring; valves enclosed.'

Affinities: With *E. salicifolia* and *E. radiata* Sieber. The larger and different shaped fruits of the *E. tenuiramis* undoubtedly are those of the *E. Risdoni* hybrids above mentioned.

20. **E. linearis** Dehn. Dehnhardt, 1832—Cat. plant. horti. Camald., Ed. ii, 20. A small to medium tree, 6-15 m. Bark smooth, white, sometimes with bluish streaks. The narrow leaves give the tree a characteristic appearance. Juvenile leaves opposite for 5-6 pairs, minutely petiolate, linear to linear-lanceolate, 4-6 × 0·2-0·3 cm. Mature leaves alternate, petiolate, linear to linear-lanceolate or linear-falcate, 5-12 × 0·3-0·5 cm. Umbels axillary, 5-12 flowered. Peduncles terete to somewhat compressed, 7-10 mm. Buds clavate, shortly pedicellate, 4-5 × 2-4 mm. Operculum hemispherical, minutely apiculate, shorter than the calyx-tube. Fruit petiolate, broadly globose to sub-pyriform, 4-6 × 3-8 mm.; disc flat or oblique; valves enclosed.

Habitat: Shows adaptability to a variety of soils, but probably does best in those of a porous, light nature. Grows from sea-level to a moderate elevation, and thrives best in open country.

Distribution: Common in the South and East, and is closely associated with *E. viminalis* and often *E. globulus*. Some localities are: Hobart, Mt. Wellington, Kingston, Black Charlie's Opening (East Coast Road), Bagdad, Bruni Island.

Affinities: With *E. salicifolia.*

Hybrids: None observed. It is possible that the tree has had a hybrid origin from *E. salicifolia* and one of the Macrantherae, perhaps *E. viminalis*, since *E. linearis* is invariably associated with this species (see note on hybrids of *E. salicifolia*).

21. **E. Risdoni** Hook., f. Hooker, J. D., 1847—Lond. Journ. Bot., vi, 477. A very glaucous tree, 3-7·5 m. Bark smooth, deciduous, often retaining circular leaf scars until the first bark is completely shed. The bark of the adult tree is ashy-grey, streaked with cream. Juvenile leaves opposite for an indefinite number of pairs, connate, cordate-lanceolate, apiculate, glaucous, 4 × 2 cm. or larger. The connate character of the juvenile leaves is important. (Seedlings departing from this, and matching those in a hybrid swarm from a recognisable hybrid, sometimes occur in batches, raised from what is apparently a pure type.) It is suggested in this paper that the connate leaves are a constant character of the biotype, and the many departures noted in the various sessile or amplexicaul forms are due to hybridization. It is difficult to determine an intermediate leaf stage. Mature leaves opposite, connate, similar in shape to the juvenile, but becoming more lanceolate and sub-acuminate, strongly glaucous to dark glossy-green. The occasional alternate leaves observed ('Key to Eucalypts', Blakely, p. 214), it is suggested, are due to hybrid influence. Umbels axillary, 3-9 flowered. Peduncles terete to somewhat compressed, 7-10 mm. Buds clavate, strongly glaucous, pedicellate, 5-6 × 4-5 mm. Operculum hemispherical, obtuse, or apiculate, shorter than the calyx-tube. Fruit pedicellate, pyriform-truncate to nearly hemispherical, 6 × 8-10 mm. Disc moderately wide to thin and shrunken, flat to sub-oblique. Valves deeply to slightly enclosed.

Habitat: Prefers mudstone hills. The stock is non-viable and differs markedly in this respect from the forms classed under *E. Tasmanica* Blakely or the polymorphic group × *E. Risdelata.*

Distribution: Extends from Risdon, following permo-carb. formations, to Cambridge. Muddy Plains and the valley of the South Esk are quoted by Blakely as localities, but I have not seen specimens from these districts. Confined to Tasmania.

The following quotation from Ewart, in 'Flora of Victoria', under *E. Australiana*—'In one form, sometimes known as *E. Risdoni*, the juvenile foliage is bluish-grey, with broad bases united across the stem'—must astonish any one who knows both species in the field or herbarium.

Affinities: With the polymorphic × *E. Risdelata*, which covers a great range of forms, as can be seen in Plate XVI.

Hybrids: See note on *Eucalyptus Risdoni* Hook., f.

22. E. pauciflora Sieb. Sieber, 1827—Spreng. Syst., ov., Cur. Post., 195. The following description is somewhat unwieldy, and probably covers two, if not three, biotypes. Further investigation is necessary with this species. A small to medium tree, 6-15 m. Bark smooth to base, white or ash-grey, streaked with white. A sub-alpine type, is quite fastigiate in character, and maintains this constantly; another form, often called Cabbage or Weeping gum, has remarkable pendulous branches, at times hanging in the fashion of a liana for 15 to 20 feet. Juvenile leaves opposite for 3-5 pairs, shortly petiolate, narrow to broad-lanceolate. Intermediate leaves alternate, petiolate, coriaceous, dark glossy-green to green, sub-glaucous to glaucous, up to 10-19 × 10-14 cm. or even larger. Mature leaves alternate, petiolate, with semilongitudinal venation, thick coriaceous, dark-green to green, shining, 8-14 × 1·5-4 cm. or larger. Umbels axillary, 5-15 flowered. Peduncles thick, terete, 7-25 mm. Buds clavate, pedicellate, 5-7 × 4-5 mm., angular or ribbed, glaucous or non-glaucous. Operculum hemispherical to sub-conical, acute, much shorter than the calyx-tube. Fruit pedicellate to shortly pedicellate, pyriform to pyriform-truncate or globose, glaucous or non-glaucous, 7-10 × 8-12 mm.; disc flat, broad to medium. Valves enclosed.

Habitat: Shows marked xerophytic characters at sea-level, where the tree flourishes in very dry conditions. The high-altitude forms often prefer moist, but not marshy, conditions.

Distribution: Common from sea-level to sub-alpine situations, and forms a very characteristic feature of eucalypt vegetation in the Midlands of Tasmania. The question of mainland distribution is an open one.

Affinities: Probably with *E. Simmondsi.* The following suggestions are made after an extensive field experience of the so-called *E. pauciflora* Sieb. in Tasmania. Three biotypes are tentatively suggested:—(1) The Weeping or Cabbage gum, so well-known in the Midlands of Tasmania. This was referred by Messrs. Baker and Smith, in 'Research on the Eucalypts of Tasmania', to *E. phlebophylla* F. v. M. There seems little doubt that this tree, although related to it, is specifically distinct from *E. pauciflora* Sieb. as described by Black in 'Flora of South Australia', Ewart in 'Flora of Victoria', and Blakely in 'Key to Eucalypts'. Mr. St. John, of the National Herbarium, Melbourne, a well-known authority on eucalypts, is of the opinion that the Tasmanian Cabbage gum is distinct from *E. pauciflora* Sieb. in Victoria. Fruit, buds, and branchlets often exhibit glaucousness. (2) A non-glaucous type, common in South-Eastern Tasmania and also at Sheffield. The sucker foliage

often reaches very large dimensions; the weeping character of the branches is not as marked as in the Cabbage gum. (3) A sub-alpine type, with leaves much narrower than in (1) or (2). The tree is of fastigiate appearance, which it retains after maximum development. Forests of this type are to be observed at Interlaken and the Great Lake.

Hybrids: With ×*E. Risdelata* and *E. salicifolia.* For other important notes on hybrids see *E. Dalrympleana* and *E. aggregata.*

23. **E. coccifera** Hook., f. Hooker, J. D., 1847—Lond. Journ. Bot., vi, 477. A small to medium tree, about 1-12 m. Bark smooth, deciduous to butt, slate-grey in colour. Juvenile leaves opposite for an indefinite number of pairs, sessile, elliptical or cordate-orbicular, glaucous. Intermediate leaves alternate, petiolate, oblong-lanceolate, apiculate or sub-acuminate. Sub-glaucous. Mature leaves sub-glaucous to glaucous, alternate, petiolate, uncinate, 5-6 × 1·5-2 cm. Umbels axillary, 3-6 flowered. The 3-flowered type is characteristic of the Mt. Wellington range, and apparently does not extend north of this. Peduncles compressed and often somewhat triangular in shape, or sub-terete, 5-10 mm. Buds glaucous or sub-glaucous, clavate, angular or markedly costate, 8-10 × 5-6 mm. Operculum flat or concave, much shorter than the calyx-tube. Fruit sessile, or shortly petiolate, globose to hemispherical or broadly turbinate, shining or glaucous, smooth or somewhat furrowed or bicostate, 7-9 × 10-12 mm. Disc flat or convex, 3-4 mm. broad. Valves enclosed.

Var. parviflora Benth. Bentham, 1866—Flora Aust., iii, 204. Similar to type, but floral parts and leaves much smaller. A taller tree, up to 18 m. or taller, with much less glaucousness when growing in sheltered valleys, the mature leaves sometimes with slight sheen. Buds sometimes with a calyptra.

Habitat: An alpine species, preferring an altitude of 3000-4000 feet. The type flourishes in exposed situations, while the var. *parviflora* is found in sheltered valleys, where it attains the height of a medium tree.

Distribution: Common at alpine levels throughout the Island. The 3-fruited form, as far as can be judged, is confined to the South.

Affinities: In some of its characters it presents remarkable resemblances to some of the forms of ×*E. Risdelata.*

Hybrids: None observed.

24. **E. Dalrympleana** Maiden. Maiden, 1920—Forest Flora of N.S.W., Vol. VII, Pt. IV, 137. A medium to tall tree, 12-30 m. Bark smooth, deciduous, white or pinkish, with bluish streaks and blotches. Juvenile leaves opposite for an indefinite number of pairs, sessile, varying greatly in shape, size, and degree of glaucousness, cordate to orbicular, ovate-lanceolate to oblong-lanceolate, 4-6 × 4-5 cm., and frequently much larger. Intermediate leaves opposite, petiolate, ovate to elliptical or ovate-lanceolate, varying in size

and degree of glaucousness. Mature leaves alternate, broad-lanceolate to narrow-lanceolate and lanceolate, with very long petioles, dark-green, glossy, and very coarsely veined, 10-22 × 1·5-2·5 cm., and sometimes much larger. Umbels axillary, 3-flowered. Peduncles compressed to subterete, 4-7 mm. Buds strongly pedicellate (the description 'sessile' in 'Key to Eucalypts' supports my belief that *E. Dalrympleana* is a polymorphic species belonging to Group (2), narrow to broadly ovoid, 7-8 × 3-5 mm. Operculum acutely to bluntly conical, as long as the calyx-tube. Fruit pedicellate, variable in shape and size, turbinate to globose, 7-10 × 8-9 mm. Disc domed to flat. Valves strongly exsert.

Habitat: Prefers sub-alpine situations in river valleys or alluvial flats.

Distribution: Common at altitudes between 2000 and 3000 feet. Tasmania: Waddamana, Lake St. Clair, Middlesex Plains, &c. Also New South Wales and Victoria.

Affinities: With *E. rubida* and *E. viminalis.*

Hybrids: With *E. rubida* where the two meet. From impressions in the field, and a study of seedlings, there is a possibility that the species had its origin in *E. rubida* and one or more others, including *E. pauciflora.* The evidence is not strong enough yet to advance this as any more than an opinion.

25. **E. Johnstoni** Maiden (*E. Muelleri* T. B. Moore). Maiden, 1922—Crit. Rev., Pt. LVI, 280. Moore, T. B., 1886—Proc. Roy. Soc. Tas., 207. A small to medium tree, 9-12 m. Bark smooth, deciduous, blotched, and with a prevailing tone of olive-green. Juvenile leaves opposite for an indefinite number of pairs, sessile to shortly petiolate, crenulate and undulate, dark-green and glossy. Intermediate leaves alternate, petiolate, oblong-ovate to lanceolate, coriaceous and vernicose, subcrenulate, 3-6 × 2·5-6 cm. Mature leaves dark-green, vernicose, alternate, petiolate, lanceolate to narrow-falcate-lanceolate 5-10 × 1·5-3 cm. Umbels axillary, 3-flowered. Peduncles compressed to strap-shaped or triangular, broad to narrow, 4-7 mm. Buds sessile, broadly turbinate to subelliptical, angular, 3 or 4 ribbed, 8-14 × 6-10 mm. Operculum flat, markedly umbonate or ridged across the top, shorter than the calyx-tube. Fruit hemispherical to broadly turbinate, 2-3 ribbed or narrowly winged, 7-10 × 10-14 mm. Disc domed, prominent. Valves large and exsert.

There is little doubt that the descriptions of this species have been based on the Mt. Wellington forms, but T. B. Moore included the very similar *E. subcrenulata* in the distribution. A study of a large quantity of material selected for as wide a range in size of fruit as possible reveals the existence of two forms: one, a large fruited type, tends in leaves and shape of buds towards *E. globulus*; the other shows transit to *E. subcrenulata.* The above measurements in the description indicate a very wide spread in the characters

chosen. It is here suggested that *E. Johnstoni* has arisen from *E. globulus* and *E. subcrenulata*, and is in process of becoming stabilized. A possible future course might be to establish two biotypes, or by a process of future intraspecific hybridization evolve a single biotype intermediate between the abovementioned forms. In support of this suggestion, which is based upon a close comparison between reproductive parts of *E. subcrenulata* and *E. Johnstoni*, it may be mentioned that, as far as can be ascertained, *E. Johnstoni* is confined to Mt. Wellington, and *E. subcrenulata* does not associate with *E. globulus*, which grows on the lower slopes of Mt. Wellington. There is apparently no *E. subcrenulata* on Mt. Wellington. In further support of the possibility, it may be added that Prof. A. L. McAulay and myself have independently concluded, on field and horticultural evidence, that the non-glaucous *E. urnigera*, confined to the south-east and south face of Mt. Wellington, has probably arisen from *E. Johnstoni* and *E. urnigera*, which latter is a markedly glaucous species on the eastern face of Mt. Wellington and in its wide distribution beyond this. The probability of an *E. globulus* component is increased by the extreme difficulty of separating some forms of *E. unialata*, an established hybrid of *E. globulus*, from the coarser fruited form of *E. Johnstoni*.

Habitat: Sub-alpine to alpine.

Distribution: As far as known at present, confined to Mt. Wellington.

Affinities: With *E. globulus*, *E. subcrenulata*, and *E. vernicosa*.

Hybrids: With *E. urnigera*.

26. **E. Simmondsi** Maiden. Maiden, 1922—Crit. Rev., Pt. LVII, 344. The following description is quoted from 'Key to Eucalypts' (Blakely): 'A tree 40-60 feet high (about 12-20 m.). Bark rough, fibrous, persistent on stem, branches smooth or ribbony. Timber pale, reputed durable. Juvenile leaves opposite for a large number of pairs, glaucous, ovate to broadly lanceolate, sessile to shortly petiolate, 5-10 × 3-5 cm. Mature leaves alternate, petiolate, coriaceous, lanceolate, 10-15 × 1-2 cm. Venation more or less longitudinal. Umbels axillary, 5-15 flowered. Peduncles terete or nearly so, 5-7 mm. long. Buds clavate, shortly pedicellate, 6-7 × 5-6 mm. Operculum hemispherical, less than half as long as the calyx-tube, obtuse or slightly umbonate. Fruits conoid to turbinate, 9-10 mm.; disc well defined, convexed, almost enclosing the short valves.

'An imperfectly known species from Smithton, Tasmania. Flowers about December'.

Distribution: The type specimen is given as collected at Smithton. I am not familiar with the trees in the field. As far as yet known confined to Tasmania.

Affinities: From the robustness and length of the pedicels, and the nature of the venation and the juvenile foliage, the suggestion

is that its origin is *E. pauciflora* and one of the macrantherae, possibly *E. viminalis*. I have collected material similar to this in the Cradle Mt. area, and make the very tentative suggestion that *E. Simmondsi* is polymorphic and belongs to Group II.

27. **E. Tasmanica** Blakely. (*E. Risdoni* Hook., f., var. *E. elata* Benth., in part.) Blakely, 1934—'Key to Eucalypts', p. 214. The type description is quoted below: 'Arbor insigniter glauca, 30-70 pedes alta (circa 9-21 m.) cortice levi, deciduo. Folia juvenilia opposita, sessilia, cordato-lanceolata, connata, 3-6 cm. longa, 2·5-5 cm. lata. Folia matura alterna, petiolata, angusto-lanceolata, acuminata, 5-16 cm. longa, 1-3·5 cm. lata. Inflorescentia in umbellis axillaribus, 6-25 floris. Gemmae clavatae, glaucae, 5-6 mm. longae, 5 mm. latae, in crassos pedicellos angustatae. Operculum patelliforme, claycis tubo brevius. Antherae reniformes. Capsulae turbinatae vel subpyriformes, truncatae, pedicellatae, 9-13 mm. longae, 7-11 mm. latae.'

A study of Plate XVI will show that this description only covers part of the polymorphic $\times$*E. Risdelata*. The operculum in fig. 3 is not patelliform. From a study of the type description I suggest that *E. Tasmanica* Blakely is $\times$*E. Risdomacranthelata* in part.

Distribution: Very widely distributed throughout Tasmania, and is confined to the State.

Affinities: With *E. Risdoni.*

28. **E. unialata** Baker and Smith. (*E. viminalis*, var. *macrocarpa* Rodway.) Baker and Smith, 1912—Proc. Roy. Soc. Tas., 176. A small to medium tree, 6-12 m. Bark smooth, deciduous, white in colour, or rough lightly furrowed with kino exudations, ribbony on branches. Juvenile leaves opposite for an indefinite number of pairs, glaucous, ovate to ovate-cordate to oblong-lanceolate, 5-7 $\times$ 1·5-3 cm. or larger. Intermediate foliage petiolate, short-lanceolate to falcate-lanceolate. Mature leaves petiolate, with resemblance to those of *E. globulus* and *E. viminalis*, acuminate, dark-green, subvernicose, up to 19 $\times$ 1·5-2 cm. Umbels axillary, 3-flowered. Peduncles broad, compressed, 3-5 mm. Buds elliptical, sessile, or subsessile, green or subglaucous, 10-15 $\times$ 7-10 mm. Operculum obtusely conical to subrostrate, as long as the calyx-tube. Fruit sessile, broadly obconical, turbinate or hemispherical. Disc flat or convex, valves slightly to strongly exsert.

Habitat: Only occurs as isolated trees in associations of *E. globulus* and *E. viminalis.*

Distribution: Tasmania—Eaglehawk Neck, Grass Tree Hill, Lindisfarne, Bellerive, Mt. Nelson. Also on Port Phillip Island.

Affinities: With *E. globulus, E. viminalis,* and *E. Johnstoni.*

29. **E. biangularis** Simmonds. Maiden, 1927—Crit. Rev., Pt. LXVIII, 382. The following note by Simmonds appears on the label of the type specimen: 'Tree in grounds of W. D. Hunt, Invercargill, New

Zealand. In general aspect and bark, similar to *E. urnigera*. Jan. 14, 1918'. There is no record of a tree similar to this growing naturally in Tasmania. In the absence of any field notes the following description is quoted from 'Key to Eucalypts' (Blakely): 'A tree 40-100 feet high (about 12-24 m.), with a smooth deciduous bark. Timber not seen. Juvenile leaves opposite for an indefinite number of pairs, glaucous or pale-green, sessile cordate. Mature leaves alternate, petiolate, narrow to broad-lanceolate, 14-17 × 1·3-3·5 cm. Umbels axillary, 3-flowered. Peduncles strap-shaped. 10-17 mm. long. Buds turbinate, glaucous or brownish, sessile or nearly so, biangular, very warty, 20 × 13 mm. Operculum broadly conical or cap-like, warty, shorter than the calyx-tube. Anthers versatile, oblong, opening in parallel slits, gland ovate, moderately large. Fruit urceolate to campanulate, biangular, with very short compressed pedicels, 27 × 20 mm. Disc thin, somewhat doubled, the inner portion broad and convex; valves deeply enclosed (Teddington, Botanic Gardens, Christchurch, New Zealand); grown from seed imported from Tasmania'.

Affinities: The suggestion of *E. globulus* × *E. urnigera* is very strong. *E. globulus* produces an occasional hybrid with the allied *E. cordata* (see *E. globulus*, var. *Harrisoni*, in the Rodway Herbarium).

30. E. **Irbyi** Baker and Smith. Baker and Smith, 1920—Research on the Eucalypts, 2nd edition, 242. A small tree, up to 12 m., with a smooth bark, pale or ashy coloured. Juvenile leaves opposite for an indefinite number of pairs, sessile to shortly petiolate, glaucous, ovate to cordate. I have not yet been able to verify the statement 'juvenile leaves opposite for several pairs' ('A Key to Eucalypts', Blakely). Intermediate leaves alternate, petiolate, broadly lanceolate. Mature leaves alternate, petiolate, narrow-lanceolate to ovate-lanceolate, 10-20 × 1·5-2·5 cm. Umbels axillary, 3-flowered. Peduncles terete, 4-7 mm. long. Buds distinctly pedicellate to shortly pedicellate, with turbinate calyx-tube, 5-6 × 4-5 mm. Operculum shorter than calyx-tube, blunt to apiculate or subrostrate. Fruit hemispherical to sub-cylindrical, glaucous to non-glaucous, pedicellate, 7 × 7-9 mm. in diameter. Valves slightly exsert.

Habitat: Trees are isolated, and do not form pure stands, and are found only in association with *E. Gunnii* and *E. Dalrympleana*.

Distribution: Not reported outside Tasmania. Alma Tier. Similar forms can be found in the *E. Gunnii* and *E. Dalrympleana* association at Daisy Dell, in the Cradle Mt. area.

Affinities: With *E. Gunnii* and *E. Dalrympleana*. This tree, which combines the characters of both species, is of direct hybrid origin, and its hybrid character is observable even in the cotyledon stage.

31. E. taeniola Baker and Smith. Baker and Smith, 1912—Proc. Roy. Soc. Tas., 198. A medium tree, 12-15 m. Bark fibrous and persistent on trunk, dark-grey, furrowed, and resembling that of *E. Sieberiana*, upper branches smooth. Juvenile leaves opposite for 4-5 pairs, petiolate, narrow-lanceolate, pale-green, 10-15 × 1·5 cm. Intermediate leaves petiolate, narrow-lanceolate to falcate-lanceolate, mainly with semilongitudinal venation, a few pinnately veined. Mature leaves alternate, narrow to broad-lanceolate and subfalcate, 8-20 × 1-2·5 cm., venation semilongitudinal. Umbels axillary, 3-7 flowered. Peduncles strap-shaped, 5-12 mm. Buds clavate, pedicellate, 6-7 × 3-4 mm. Operculum hemispherical, apiculate, shorter than the calyx-tube. Fruit pedicellate, pyriform-truncate to pyriform-globose, subfalcate, 7-9 × 5-9 mm. Disc flat to oblique. Valves deeply enclosed.

Habitat: Found as isolated trees only in mixed stands of *E. salicifolia* and *E. Sieberiana*.

Distribution: Not reported outside Tasmania. St. Mary's Pass, St. Helens.

Affinities: With *E. Sieberiana* and *E. salicifolia*. There is every indication that the tree is *E. Sieberiana* × *E. salicifolia*. The hybrid character is evident at the cotyledon stage.

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References

Baker, R. T., and Smith, H. G., 1912.—Pap. Roy. Soc. Tas. p. 139.

Black, J. M., 1926.—Flora of South Australia; Pt. 3. Gov. Printer, Adelaide.

Blakely, W. F., 1934.—A Key to the Eucalypts. The Worker Trustees, Sydney.

DARLINGTON, C. D., 1932.—Recent Advances in Cytology. J. & A. Churchill Ltd.

EWART, A. T., 1930.—Flora of Victoria. Gov. Printer, Melbourne.

MAIDEN, J. H., 1909-29.—A Critical Revision of the Genus Eucalyptus. Gov. Printer, Sydney.

————————, 1904-24.—Forest Flora of N.S.W. Gov. Printer, Sydney.

————————, 1902.—Pap. Roy. Soc. Tas. pp. 79, 83.

————————, 1914.—Pap. Roy. Soc. Tas. p. 22.

————————, 1918.—Pap. Roy. Soc. Tas. p. 82.

OSBORN, T. G. B., 1937.—Proc. Linn. Soc. N.S.W. 62. p. 73.

RODWAY, L., 1903.—Flora of Tasmania. Gov. Printer, Hobart.

————————, 1910.—Pap. Roy. Soc. Tas. p. 367.

————————, 1917.—Pap. Roy. Soc. Tas. p. 10.

————————, 1926.—Pap. Roy. Soc. Tas. p. 118.

PLATE XV

Figs. 1-5 represent seedlings from *E. urialata*, components of ×*E. vimiglobulus*.

Fig. 1.—Seedling indistinguishable from *E. globulus*.

Fig. 2.—Leaves glaucous but narrower than those in fig. 1.

Fig. 3.—Seedling showing leaves similar to those on specimens from Mt. Nelson labelled *E. Dalrympleana* by Maiden.

Fig. 4.—Juvenile leaves; would match those on many trees that are at present classed as *E. viminalis*.

Fig. 5.—Seedling indistinguishable from *E. viminalis*.

Fig. 6.—Specimens of *E. urialata*, showing capsules from which seedlings in figs. 1-5 were obtained.

Fig. 7.—*E. globulus* with the majority of the umbels 3-fruited. Probably a component of ×*E. vimiglobulus*.

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PLATE XVI

Fig. 1.—Probably × *E. Risdocordelata*, obtained from an association of × *E. Risdelata* and *E. cordata.*

Fig. 2.—× *E. Risdomacranthelata.*

Fig. 3.—× *E. Risdopaucilata.* The figure does not indicate the semi-longitudinal venation shown in the leaves. Fruit and leaves are similar to hybrids of *E. pauciflora* and *E. salicifolia.*

Fig. 4.—A good example of × *E. Risdobliquclata.*

Fig. 5.—Typical × *E. Risdosalicilata.*

Fig. 6.—× *E. Risdomacranthersalicilata.* Gives a swarm segregating towards × *E. Risdomacranthelata* and *E. salicifolia.*

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PLATE XVII

Eucalyptus divaricata

A. Immature fruit. B. Mature fruit.

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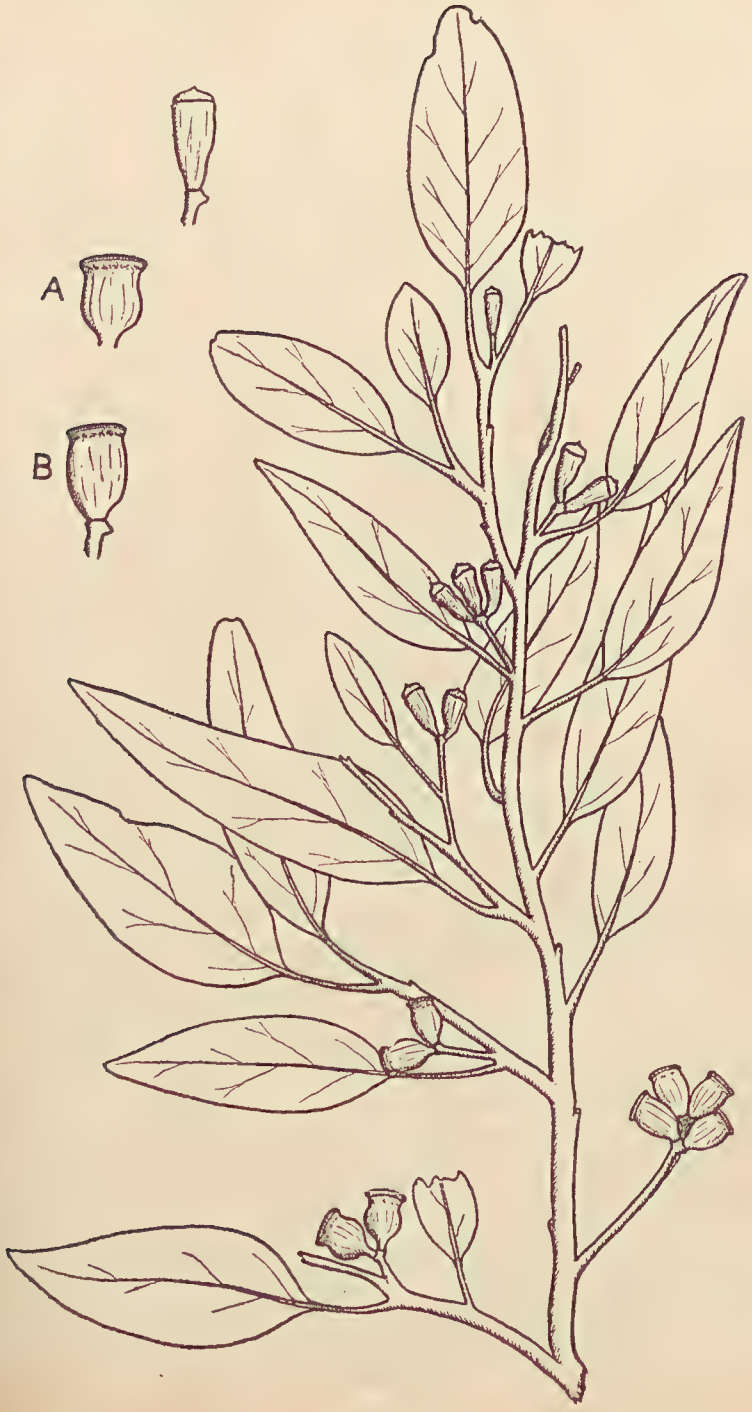
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Observations on Fishes of the Family Galaxiidae
Part II

By

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(Read 8th November, 1937)

Plates XVIII-XXVII

In Part I of these Observations (Scott, 1936), devoted to a taxonomic survey of the family, with descriptions of new species, the hope was expressed that in succeeding parts it would be found possible to consider the Tasmanian Galaxiidae described prior to 1936. The present contribution contains some biometric observations on the widely distributed *Galaxias* (*Galaxias*) *attenuatus* (Jenyns), relating chiefly to frequency distribution of standard length, including seasonal variations; rate of growth; variation of proportions with growth; growth-gradients; extra-aqueous viability. Non-metrical observations on this species are reserved for a subsequent communication.

Conventions and Abbreviations

(*a*) *Unit of Measurement.* Except where otherwise expressly noted, all linear dimensions are recorded in millimetres; and, save in a few cases in which such procedure might result in uncertainty or confusion, considerable typographic economy is achieved by the systematic omission in the body of the paper of the unit of measurement.

(*b*) *Criteria of Length.* Total length (from tip of snout to tip of normally extended caudal fin; between parallels), and standard length (from tip of snout to hypural fan; between parallels) are designated by **LT**, **LS**, respectively.

(*c*) *Groups of Material.* PC, NPC, TT denote, respectively, metrically examined material from Punchbowl Creek, from Tasmanian localities other than Punchbowl Creek, from all Tasmanian localities.

(*d*) *Mathematical Conventions and Abbreviations.* Length-classes are designated by value of midpoint of relevant interval (*e.g.*, 45 = class-value of 40 – 50). b = fractional coefficient (in simple heterogony

formula $y = bx^k$). (f) = frequency in a class-interval. h = width of class-interval. k = growth-coefficient (in simple heterogony formula $y = bx^k$). Md = median: in series with even number of terms Md is taken as arithmetic mean of bracketing terms; and is not weighted. M_o = mode; throughout crude, not weighted in short series. n = number of individuals. N_s = survival-sequence number. Q, Q_1, Q_3 = quartile deviation, first quartile, third quartile, respectively. S_k = measure of skewness (Pearson's approximate formula $S_k = \frac{3(\bar{x} - \mathrm{Md})}{\sigma}$ used). V = coefficient of variation $\left(V = \frac{\sigma}{\bar{x}} \times 100\right)$. $\bar{x}$ = arithmetic mean. σ = standard deviation $= \sqrt{\frac{\Sigma (x - \bar{x})^2}{n}}$: no substitution of $n - 1$ for n in small series (Huxley *et al.*, 1927).

Material and Localities

Material examined comprises upwards of sixteen hundred specimens, representing some thirty Tasmanian, and several extralimital, localities. It may conveniently be enumerated under the four headings noted below: The addition of an asterisk indicates that in the series thus marked *G.* (*G.*) *attenuatus* (Jenyns) occurs in association with *G.* (*G.*) *truttaceus* Cuvier.

(*a*) *Punchbowl Creek, Launceston.* 41 series. Locality indicated by C in accompanying map (Fig. 1). Series 11, 6 2 34; 27, 7/5 34; 36, 22/7/34; 44, 24 11/34; 45, 25/11/34; 46, 2/12 34; 55, 6/1/35; 61, 10 2 35; 70, 10 3 35; 73, 74, 7/4 35; 81, 18/8 35; 89*, 8 11 35; 90*, 10 11 35; 91*, 24/11/35; 92*, 15/12 35; 104, 16/2 36; 113, 27 9/36; 114, 4/10 36; 115*, 18/10/36; 117*, 22/11/36; 119, 31/12/36; 123, 124*, 125*, 126*, 127, 128, 31/1/37, 14/2 37, 7/3/37 (two examples on each date); 129*, 21/3 37; 132, 6/4 37; 133-138, 18/4 37, 9/5 37, 13 6 37 (two examples on each date); 139, 25/7 37; 141, 142, 10 9/37; 143, 26/9/37; 144, 6/10 37. Where two series are entered under one date, the first is from *Larnoo* section, second from Reserve section.

(*b*) *Other Tasmanian Localities.* 42 series. Localities shown by A-B, D-Z, a-b, d-e. Series 4*, Kelso (A), 22 12 33 (R. Slater); 8, marsh near Low Head (B), 22/1 34 (R. Green); 13, East Risdon (D), 17/2 34 (V. V. Hickman); 14 and 15, River Tamar, at Launceston (E), 9 3 34 and 12 3 34; 17*, Cox's Creek, Wynyard (F), 29/3/34 (J. Harrison); 18*, North Esk, at St. Leonards (G), 29 3 34 (A. L. Meston); 26, River Tamar (H), 18/4 34 (J. Tyler); 28*, Franklin (I), 26/4 34 (A. B. Gaul); 37, creek at Kimberley (J), 3 9 34 (A. Knowles); 38*, 39*, 40*, River Tamar (H), 17 9 34 (whitebait); 41*, Upper Scamander (K), 18 10/34 (A. E.

Elms); 42, South Esk, at Launceston (L), 20/11/34; 43*, Cox's Creek, Wynyard (F), 24/11/34 (J. Harrison); 50, creek at *Heazleton*, Ulverstone (M), 23/12/34; 51, Button's Creek, Ulverstone (N), 24/12/34; 52* and 53*, Cox's Creek, Wynyard (F), 27/12/34; 54*, Clayton Rivulet (C), 31/12/34; 58, Kelso (A), 29/1/35 (R. Slater); 72*, Devonport (P), 14/3/35 (A. Smith); 76, Meredith River (Q), 21/4/35 (G. V. Colchester); 82, Button's Creek, Ulverstone (N), 28/8/35; 83, creek at *Heazleton*, Ulverstone (M), 29/8/35; 84, Beattie's Creek, Forth (R), 31/8/35; 85, Don River (S), 31/8/35; 86*, creek at Spreyton (T), 1/9/35; 93, Young Town (U), 28/12/35 (R. Gardam); 95*, creek about 4 miles south of Sorell, West Coast (V), 2/1/36 (A. L. Meston); 103, Kelso (A), 17/4/35 (R. Slater); 106, North Esk, at Killafaddy (X), 20/1/35; 107, Button's Creek, Ulverstone (N), 25/12/35; 108*, Latrobe (Y), 14/9/35 (whitebait); 109*, Big Eel Creek, near Temma (Z), 6/2/36 (S. L. Larnach); 110* and 111*, Mella (a), 17/4/36 and 28/4/36 (B. Burnley); 118*, Stony Creek, near Swansea (b), 2/12/36 (G. C. McKinlay); 120*, Pieman River, at mouth (d), 23/1/37 (A. L. Meston); 140, Welcome River (e), 30/12/36 (A. L. Meston).

(*c*) *Extralimital Material.* Material from Flinders Island (not included in map, and conveniently dealt with in this section), and from several Australian and South American localities, has also been examined.

(*d*) *Tank-Series.* Specimens from various localities, the most important being Punchbowl Creek, Launceston, have been kept alive in observation tanks over a period of three years.

In Table I a dagger indicates the series is bimodal or plurimodal. Values for these series are as follows. (a) **LS.**—Series No. 13; modal classes 75, 95 [4]: 15; 75, 85, 95, 105 [2]: 41; 85, 95, 105, 115 [1]: 54; 45, 55 [7]: 58; 175, 185 [1]: 76; 105, 115 [2]: 109; 75, 95, 105 [1]: 113; 55, 65 [2]: 119; 45, 55 [7]: 135; 45, 55 [2]. (b) **LT.**—15; 85, 95, 115 [2]: 17; 55, 95 [3]: 58; 195, 205 [1]: 70; 55, 65 [15]: 76; 115, 125 [2]: 109; 95, 105, 125 [1]: 113; 65, 75 [2]: 114; 65, 75, 85 [3]: 127; 55, 65 [7]: 136; 45, 55 [8]: 140; 85, 105 [4].

Specification of LS, LT

LS, LT have been determined for 62 Tasmanian series, comprising 1415 individuals, from 24 localities [1]: this material is specified, first, by series (min., max., $\bar{x}$, Md, M_o, σ) in Table I, secondly, in three groups, below.

[1] This represents nearly 90% of Tasmanian specimens. Material not subjected to metrical examination consists essentially of tank-series, whitebait-series, and series consisting of only a single individual: further, several Punchbowl series collected otherwise than by trapping, though actually measured, are here excluded from consideration in order to secure a more representative, more nearly random, sampling of the stream-population.

TABLE I.

Galaxias (G.) attenuatus (Jenyns)

SPECIFICATION OF LS, LT: 62 SERIES, 1415 INDIVIDUALS

Material		Standard Length = LS (mm.)						Total Length = LT (mm.)					
Series No.	No. of Individuals	Min.	Max.	x	Md	M_0 (h = 10) No. of cases	σ	Min.	Max.	$\bar{x}$	Md	M_0 (h = 10) No. of cases	σ
8	4	96·1	119·6	108·7	109·5	115 [2]	8·96	110·1	134·2	123·1	124·1	115 [2]	9·21
13	16	55·0	113·0	90·9	95·8	†	15·44	63·0	130·0	104·0	110·5	115 [6]	17·62
14	10	67·5	97·9	87·1	90·2	95 [5]	8·34	78·0	109·9	99·1	102·6	105 [6]	8·91
15	9	53·2	109·3	86·6	86·2	†	16·79	61·7	124·2	98·9	99·0	†	17·97
17	12	44·1	96·5	68·4	67·4	85 [3]	15·32	50·7	109·0	70·3	76·7	†	17·30
18	5	54·5	64·0	59·2	60·0	65 [3]	3·34	62·9	73·0	68·1	68·6	65 [3]	3·56
26	3	64·1	80·1	70·5	67·2	65 [2]	6·93	74·2	90·8	80·7	77·0	75 [2]	7·26
36*	3	74·3	85·0	78·4	76·0	75 [2]	4·70	82·5	96·1	88·2	86·0	85 [2]	5·77
37	3	70·9	83·1	78·0	80·1	85 [2]	5·19	81·9	95·2	89·6	91·6	95 [2]	5·62
41	4	81·2	112·0	97·5	98·4	†	11·19	92·7	127·4	111·6	113·1	115 [2]	12·45
43	6	68·9	108·0	94·6	96·3	95 [3]	12·53	77·6	123·0	107·0	108·2	105 [3]	14·56
45*	21	36·1	47·0	42·4	42·6	45 [16]	2·71	41·1	52·6	48·3	48·4	45 [16]	2·84
46*	32	36·5	57·8	43·8	43·1	45 [22]	5·43	42·0	65·1	49·9	49·0	45 [19]	5·84
50	9	46·1	64·0	53·0	51·3	55 [6]	5·27	53·0	72·0	60·4	59·0	55 [6]	5·48
51	33	34·9	93·2	49·2	43·4	45 [13]	15·66	40·0	106·1	55·9	49·0	45 [16]	17·80
52	78	33·4	60·2	50·1	49·6	45 [40]	4·33	38·5	69·1	57·1	56·5	55 [51]	4·96
53	15	42·6	57·0	49·6	48·2	45 [9]	4·13	49·0	64·6	56·5	55·9	55 [10]	4·89
54	29	40·6	88·3	59·2	60·1	†	11·27	46·0	100·5	68·1	68·9	65 [8]	10·95
55*	85	38·0	81·9	48·7	47·8	45 [46]	8·10	43·5	92·2	55·4	53·8	55 [29]	9·12
58	2	172·0	185·0	178·5	178·5	†	6·50	192·0	207·0	199·5	199·5	†	7·50
61*	43	37·5	72·0	47·4	44·5	45 [27]	8·81	43·0	82·0	54·2	51·0	45 [19]	8·94
70*	48	36·0	87·0	55·5	55·4	55 [18]	10·04	41·5	99·0	64·3	62·6	†	11·05
73*	29	39·0	88·0	54·4	51·0	55 [12]	11·75	45·0	100·0	62·6	60·0	55 [13]	13·35

74*	25	41·6	71·9	51·2	50·0	45 [12]	7·24	48·0	82·0	58·5	58·0	55 [13]	8·06
76	6	98·0	124·0	109·6	110·0	†	8·87	113·5	145·0	126·3	126·0	†	10·60
81*	11	44·7	77·1	57·7	58·0	45 [4]	11·86	50·5	87·6	65·9	66·6	55 [5]	13·32
82	33	36·6	74·2	46·2	41·2	45 [15]	9·34	42·3	84·2	52·6	46·5	45 [23]	10·84
83	3	71·5	87·1	78·1	75·6	75 [2]	6·60	83·1	100·3	90·2	87·2	85 [2]	7·34
84	27	31·1	70·7	42·1	40·1	35 [13]	9·41	35·8	90·1	47·8	45·4	45 [24]	11·30
86	9	48·0	72·1	55·3	52·1	55 [4]	7·69	56·0	82·6	63·8	60·1	55 [5]	8·63
89*	33	33·5	51·5	40·4	39·0	35 [19]	4·72	38·8	58·5	45·4	44·0	45 [26]	5·34
90*	10	38·3	89·0	47·5	40·0	35 [5]	14·67	43·5	98·5	53·8	45·3	45 [6]	15·72
91*	55	34·1	88·8	43·1	41·5	35 [26]	9·45	39·5	99·0	49·3	47·2	45 [34]	10·74
92*	35	33·5	92·6	50·4	41·2	35 [16]	17·70	37·9	106·7	58·0	47·7	45 [19]	20·44
93	5	75·7	98·4	88·7	90·6	95 [3]	8·63	87·3	109·6	100·2	102·0	105 [3]	8·81
95	25	47·7	109·5	87·2	100·1	105 [3]	27·24	56·3	124·5	96·3	114·8	125 [2]	30·60
100	34	35·6	48·7	39·5	38·6	35 [19]	2·76	41·8	55·7	45·2	44·5	45 [23]	3·30
106	31	37·5	70·4	52·6	54·1	55 [16]	8·83	42·5	81·1	59·9	60·9	65 [13]	8·54
107	3	39·7	92·5	51·3	47·6	45 [20]	11·13	45·1	103·4	57·5	54·0	55 [18]	12·42
109	3	79·9	106·0	93·8	95·4	†	10·74	94·3	121·1	108·2	109·3	†	10·96
110	73	64·0	133·8	92·9	100·5	105 [17]	17·81	72·5	151·5	107·6	114·0	125 [15]	19·87
111	14	34·6	123·2	62·1	56·1	55 [4]	25·58	40·1	138·4	71·9	64·5	65 [5]	28·75
113*	5	53·5	79·0	64·2	65·2	†	9·23	62·0	89·0	73·3	74·5	†	9·29
114*	11	51·6	84·6	65·6	62·1	65 [4]	9·54	59·0	93·0	74·5	70·5	†	10·14
115*	43	34·4	90·1	42·5	39·7	35 [29]	9·98	40·3	104·0	48·6	45·2	45 [39]	11·32
117*	57	36·5	65·3	42·8	41·8	45 [36]	4·28	41·7	73·9	48·8	47·8	45 [39]	5·91
119*	16	40·3	65·5	51·2	50·3	†	6·92	46·2	74·5	58·7	57·6	55 [7]	7·88
123*	31	41·0	90·7	58·1	57·2	55 [14]	10·77	47·0	102·0	66·0	64·6	65 [14]	11·70
124*	43	37·5	80·8	47·3	44·5	45 [26]	7·73	43·9	93·0	54·1	51·3	45 [20]	8·94
125*	32	36·4	62·2	49·1	51·4	55 [16]	6·65	42·1	70·8	56·8	55·1	55 [16]	7·50
126*	21	35·1	65·0	42·1	42·5	45 [13]	6·84	41·0	74·1	50·4	48·0	45 [14]	7·32
127*	20	39·0	80·1	56·4	52·1	55 [9]	11·92	44·9	91·9	64·7	60·2	†	13·49
128*	32	36·0	46·0	40·1	39·0	35 [20]	3·13	41·5	52·6	46·1	45·0	45 [26]	3·17
129*	51	33·6	83·1	44·4	42·5	45 [27]	8·97	39·0	95·9	51·9	48·6	45 [25]	10·24
133*	17	45·1	66·5	54·7	53·3	45 [7]	7·00	51·8	76·2	62·4	60·7	55 [7]	7·79
134*	20	37·2	50·1	42·6	42·7	45 [14]	3·24	43·2	57·3	48·4	48·5	45 [14]	3·61
135*	5	43·2	63·1	53·4	52·8	†	7·66	49·6	71·9	61·3	61·2	65 [2]	8·44
136*	21	37·6	58·5	47·1	46·5	45 [11]	6·01	43·2	67·1	54·0	53·2	†	6·87
137*	7	38·7	47·0	44·1	44·6	45 [6]	2·48	44·3	54·0	50·3	50·4	55 [5]	2·79
138*	22	35·4	54·8	42·7	41·5	45 [12]	4·57	41·0	62·8	48·1	48·8	45 [17]	5·52
139*	13	42·7	67·5	48·9	47·6	45 [10]	6·63	48·4	77·0	56·2	55·0	55 [8]	7·47
140	12	59·9	107·4	87·2	91·2	75 [4]	13·98	69·0	121·0	99·1	102·8	†	15·35

(*a*) *Punchbowl Creek.* PC [1] material comprises 32 series, 897 specimens. All series trapped. Statistics of **LS**, **LT** for separate series exhibited in Table I. For total PC material we have, as regards **LS**, min. 33·5, max. 92·6, $\bar{x}$ 47·94, Q_1 39·66, Md 43·93, Q_3 51·62, M_0 (with $h = 10$) 45 (429 cases), σ 10·445: as regards **LT**, min. 37·9, max. 106·7, $\bar{x}$ 55·02, Q_1 45·40, Md 50·23, Q_3 59·18, M_0 45 (397 cases), σ 11·865. **LS** deciles are 37·4, 39·0, 40·4, 42·1, 43·9, 46·4, 49·8, 53·8, 60·2.

This material is peculiarly appropriate for the investigation of frequency distribution, and, in spite of the absence of very small and of very large individuals, almost certainly provides, at least between the limits $33 \leq \mathbf{LS} \leq 92$, a more characteristic sample of the general population than that afforded by NPC and TT material.

Its more homogeneous and typical character is attributed, first, to the single source of the material; [2] secondly, to reasonably regular distribution over the various months of the season, and thirdly, and, in practice, most notably, to the method of collection, namely trapping, [3] which results in the elimination, or at least the great reduction, of the differential effects of angling and hand-netting, reliance on which methods commonly tends—partly on the ground of mere physical facility, and partly from conscious and unconscious selection

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[1] The abbreviations PC (= Punchbowl Creek), NPC (= Tasmanian; Non-Punchbowl Creek), TT (= Total Tasmanian) denote only the metrically examined material, not the total material, from these localities.

[2] Punchbowl Creek, 3-4 miles long, rises among the hills westward of Young Town, and enters the North Esk River, here subject to a rise and fall of tide totalling about six feet, a few chains south of the southern boundary of *Ravenscraig*, the Scotch College estate, the northern side of which lies within 100 yards of the boundary (1935) of the City of Launceston.

Portion of the creek studied, approximately one mile, is conveniently divided into four sections, which, proceeding in direction of flow (eastward), are as follows. (1) First Reserve Section—in Punchbowl Reserve, about 230 yards long, above (west of) waterfall (about 30 feet high); no fish have been observed here. (2) Second Reserve Section—about 640 yards long, below waterfall; always with fish; material designated Reserve collected in this section. (3) *Larnoo* Section—about 540 yards long, running through Mr. H. W. A. von Steiglitz's estate *Larnoo*; greater part of material (specified as *Larnoo*) secured here. (4) *Queechy*; section—divided from (3) by large culvert beneath Penquite Road; about 340 yards long, in Mr. W. Fraser's estate *Queechy*.

[3] Very satisfactory results are obtained with a flywire minnow trap in the form of an open cylinder, about 2 feet long and 1 foot in diameter, fitted at either end with an inwardly directed cone, about 8 inches high, with the apex truncated to provide an entrance 1½-2 inches in diameter; bait (one or two worms) suspended from wire hook hanging down into middle of trap; attach 2 or 3 yards of cord to one end of trap for retrieving; immerse (bare submergence is usually advisable) for 5-10 minutes, with long axis in direction of flow of stream; a door for extraction of fish may be provided, if desired.

by the collector—to the collecting in unduly high proportions of individuals of large or moderate size (*cf.*, for instance, Regan's British Museum material, noted below).

(*b*) *Other Tasmanian Localities.*—NPC material comprises 30 series, 518 specimens, from 22 localities. Statistics of **LS**, **LT** for separate series exhibited in Table I.

For total NPC material we have, as regards **LS**, min. 31·1, max. 185·0, $\bar{x}$ 63·98, Q_1 44·55, Md 53·89, Q_3 83·13, M_0 (with $h = 10$) 45 (147 cases), σ 25·222: as regards **LT**, min. 35·8, max. 207·0, $\bar{x}$ 71·23, Q_1 50·96, Md 61·50, Q_3 92·67, M_0 55 (120 cases), σ 28·427. **LS** deciles are 38·6, 42·0, 46·4, 49·3, 53·9, 60·2, 76·4, 92·1, 104·6.

(*c*) *Total Tasmanian Material.*—TT material comprises 62 series, 1415 specimens, from 30 localities. Statistics of **LS**, **LT** for separate series exhibited in Table I.

For TT material as a whole we have, as regards **LS**, min. 31·1, max. 185·0, $\bar{x}$ 53·81, Q_1 40·50, Md 46·73, Q_3 57·06, M_0 (with $h = 10$) 45 (573 cases), σ 35·049: as regards **LT**, min. 35·8, max. 207·0, $\bar{x}$ 60·96, Q_1 46·05, Md 53·58, Q_3 65·16, M_0 45 (508 cases), σ 35·735. **LS** deciles are 37·7, 39·5, 41·5, 43·8, 46·7, 50·0, 54·4, 61·0, 83·3.

Comparison of PC, NPC, TT Material

These three groups of PC, NPC, TT material may profitably be compared by means of percentile curves[1]: those for **LS**, based on the deciles, are shown in Fig. 2.

Note general regularity of increase, proceeding to right of the ogive, of TT over PC values; with sharp ascent for max. value, largely traceable to influence of Series 58.

For PC, $Q_{LS} = 11·96$, $Q_{LT} = 13·78$; for NPC, $Q_{LS} = 38·58$, $Q_{LT} = 41.71$; for TT, $Q_{LS} = 16·56$, $Q_{LT} = 19·11$. High values of the interquartile intervals for NPC material are in part attributable to varied modes of collection, a factor whose influence in TT material is largely counteracted by the homogeneity of the numerically preponderant PC element.

[1] Percentile curve is here used for a curve having as ordinate the value of the percentile, and as abscissa the percentile index, p. The term is also often applied to a cumulative frequency curve, in which integrated frequency is represented by the ordinate, and values of the variable by the abscissa. It is more in harmony with mathematical convention to name a curve according to what is represented by the ordinate, and it is hence desirable (Holzinger, 1928) to restrict Percentile Curve to the connotation with which it is here employed.

Assuming—probably with a fair degree of accuracy—that specimens of $\bar{x}_{LS} \leq 60$ are one year old, or less; specimens of $60 > \bar{x}_{LS} > 75$ are in their second year; and specimens of LS > 80 are three years old, or more, we obtain from Fig. 2, by method of percentile ranks, the following results:—One year old or less: PC 89%, NPC 60%, TT 78%. In second year: PC 5%, NPC 9%, TT 8%. In third, or later, season: PC 4%, NPC 26%, TT 11%.

Observe also that approximate percentage of material with LS greater than max. of PC material is 20% for NPC, 9% for TT, material.

Extreme Variates.

(*a*) *Maximum.* The maximum length among the 50 specimens noted by Regan (1906, p. 369) is 170, recorded in the case of his No. 5, the type of *G. punctatus* Günther, from Eastern Creek, and his No. 21, a specimen from Tasmania, presented by Sir J. Richardson.

Clarke (1899, p. 80) observes of specimens of these species: 'They very seldom exceed a total adult length of 6 inches. The longest ever observed by me in either of the other colonies or New Zealand in an experience of forty-four years was barely 7 inches in length. Average length of adult fish, 4½ inches to 5 inches (total).'

The largest individuals I have encountered (Nos. 58 1, 2; LS 185·0, 172·0; LT 207·0, 192·0) were secured by Mr. Reg. Slater, in January, 1935, from a waterhole about 12 feet square, on his property *Paranaple*, Kelso, Northern Tasmania, and were, it is believed, two of a number placed there about four and a half years previously. The larger specimen was observed lying dead in the water, having apparently died a natural death, the smaller was netted alive. Other dimensions of these examples are (No. 58 1 noted first): head 31·0, 29·0; eye 6·0, 6·5; snout 7·25, 7·5; interorbital width 19·0, 14·0; depth of body 36·0, 30·0; thickness of body 28·5, 25·5; length to dorsal 139·0, 136·0; base of dorsal 20·0, 16·0; longest dorsal ray 20·5, 16·5; base of anal 30·0, 32·0; longest anal ray 21·5, 16·5; length of pectoral 21·0, 19·0; length to pelvic 90·0, 82·0; length of pelvic 20·0, 19·0; length of caudal peduncle, 16·0, 14·0; depth of caudal peduncle 15·0, 13·25.

Five next largest specimens are Nos. 110 7, 9, 29, 13 and No. 76/1, which have LS 133·8, 126·5, 126·0, 124·7, 124·0, and LT 151·6, 143·0, 143·5, 143·4, 145·0, respectively.

That the dimensions of Nos. 158/1, 2 are quite exceptional, is indicated by the magnitude of the interval separating No. 158/2 and No. 110/7 (interval for LS = 38·2, for LT = 40·5), resulting in the occurrence in the LS frequency table of 10-mm. classes for TT material (Fig. 6) of a hiatus (the only one present) extending over three length-classes: *cf.* also Table II.

(*b*) *Minimum.* The minimum length in Regan's material (which consists mainly of rather large specimens of average LT of the order of 80) is 55, occurring among 8 specimens of LT 55-60 from Magellan. This is far from small: of PC material 63%, of TT 53%, is of this length, or less.

McCulloch (1915), in giving an account of the immigration of *G.* (*G.*) *attenuatus* from the sea into a stream crossing the beach at Freshwater Bay, near Sydney, N.S.W., observed on 31st August, 1914, describes and figures immediately postlarval specimens, one of which is noted as having LT 38.

Minimum length among TT material is afforded by No. 84/12 (NPC), with LS 31·1, LT 35·8, the next smallest specimen being No. 52/73 (NPC), with LS 33·4, LT 38·5. Other dimensions of these examples are (No. 84/12 noted first): head 5·0, 5·5; eye 1·1, snout 1·4, 1·4; interorbital width 2·3, 2·0; depth of body 3·3, 2·8; thickness of body 2·5, 2·6; length to dorsal 21·4, 24·5; base of dorsal 3·9, 3·8; longest dorsal ray 2·2, 2·3; base of anal 4·5, 4·5; longest anal ray 2·2, 2·3; length of pectoral 3·0, 3·5; length to pelvic 15·5, 15·5; length of pelvic 2·5, 2·5; length of caudal peduncle 5·1, 3·5; depth of caudal peduncle 2·0, 1·6.

Other TT specimens of LS < 34·0 are No. 92/18 (PC), LS 33·5, LT 37·9; No. 89/18 (PC), LS 33·5, LT 38·8; No. 129/1 (PC), LS 33·6, 39·0.

The difference in LS, amounting to 2·4, between No. 84/12 and the smallest individuals among PC material (Nos. 92/12, 89/18) is probably attributable to the collection of No. 84/12 at a locality (Beattie's Creek, near Forth, about 1·5 miles from sea) nearer the coast, and hence at an earlier stage in the inland migration.

Relative Value of LL, LT Criteria

As a measure of general length of a fish, LS is, of course, morphologically superior to LT, the latter dimension including a factor, length of caudal fin (LT–LS), relating merely to an appendage collinear with the main body-axis, and hence introducing an element subject to individual variation. Curiously enough, though the contrary might

confidently be anticipated, the determination of **LS** is made in practice more readily and satisfactorily than that of **LT**, the posterior limit of the former, the hypural joint, being clearly indicated by a very nearly vertical line, normally emphasized by a narrow bar of dark pigment, whereas the latter, delimited posteriorly by the tip of the longest caudal ray, is sometimes determinable in preserved specimens only with some difficulty, on account of greater or lesser deformation and rigidity in the caudal fin, and always involves the spreading of the fin to a normal full fan (a matter of personal judgment), in order to obviate the error of arc that is otherwise introduced.

That the determination of **LS** is more consistent in actual practice than that of **LT** is shown by a comparison of the dispersions exhibited by the two quantities, due regard being paid to the relative magnitudes. In general we find $v_{LT} > v_{LS}$.

Throughout the present paper, therefore, we shall henceforth adopt, and in general confine ourselves to, **LS** as a measure of general length, recording **LT** occasionally only for special purposes (*e.g.*, for comparison with data published elsewhere).

LT a Logarithmic Function of LS

The value of the ratio **LT**/**LS** varies with absolute size of the fish: see, under *Growth-Curves* below, equation of relative growth of length of caudal fin (**LT**–**LS**).

A convenient approximation, derived directly from values of $\bar{x}_{LS}$, $\bar{x}_{LT}$ for PC, NPC, TT groups, is

$$\log \bar{x}_{LT} = 1{\cdot}03 \log \bar{x}_{LS}.$$

Larval Characters

(*a*) *Non-Metrical.* McCulloch (1915) has well described, and figured, larval specimens secured when entering a stream near Sydney from the sea on 31st August, 1914: my own observations suggest the following extensions and emendations.

I have previously (Scott, 1936, p. 87) independently observed, and discussed the taxonomic significance of, the upward deflection of the last vertebra, noted by McCulloch in his examples.

'Caudal rays blackish, the others transparent' (McCulloch, 1915, p. 48). Many of my specimens of **LS** < 40, and a few of greater **LS** (up to 47·0), show several distinct rows of spots, mainly on rays, forming distinct forwardly concave, dark arcs on anterior half, or more, of caudal. Similar curved pigment-bands occur among Tasmanian species in, *e.g.*, adult *G.* (*G.*) *affinis* Regan—though not mentioned or figured by Regan (1906, p. 380 and pl. X, fig. 1)—*Saxilaga* (*S.*) *cleaveri* (Scott),

S. (*S.*) *anguilliformis* Scott. It seems not unlikely that their presence is a primitive family character, retained in the case of *G.* (*G.*) *attenuatus* only in the larval phase.

The LS to which general transparency, accompanied by larval pattern of small spots as described by McCulloch, persists, varies considerably, even in individuals of the same sample: its retention (observable in the majority of cases in samples of the major vernal immigration) in individuals that have travelled more than 40 miles inland to Punchbowl Creek is noteworthy. Generally speaking, transparency ceases at about LS 40, but well-marked ground-pigmentation may occur (*e.g.*, No. 128 12) at LS 36·1, or may be delayed (*e.g.*, No. 86/3) to LS 55 6 (note the possible significance of this long retention of larval facies in connexion with status of *G.* (*G.*) *gracillimus* (Canestrini) discussed below).

All specimens of Series 85 (near mouth of Don River; 31.8.35) possessed a pit or furrow, indicating the point of absorption of the yolk-sac, and, just internal to, and dorsad of, this depression a bright red spot, formed by a subspherical vascular plexus, conspicuously visible through the transparent abdominal wall. Evidence of the location of the yolk-stalk, in the shape of midventral furrows or irregular depressions, and of a persistant rete is occasionally traceable in specimens entering Punchbowl Creek about October.

The striking similarity of both non-metrical and metrical characters of larval *G.* (*G.*) *attenuatus* (Jenyns) and those given for *G.* (*G.*) *gracillimus* (Canestrini) suggests the desirability of further investigation of the status of the latter species: *cf.* comments on this point long ago made by Regan (1906, p. 370).

(*b*) *Metrical.* Metrical characters of larval and immediately post-larval phases may be gathered from data given elsewhere in this paper: *cf.*, under EXTREME VARIATES, dimensions of individuals of LS 31·1, 33·4; also, under VARIATION OF PROPORTION WITH GROWTH, Table III (38·93, 45·20, LS-classes), and GROWTH-CURVES, *passim.*

Frequency Distribution of LS

1 *mm.-Classes.* With $h = 1$, PC, NPC, TT material is distributed, as regards LS, over 60, 155, 155 classes; as regards LT, over 70, 173, 173 classes, respectively. Data for LS recorded in Table II. For compactness, length-classes are not listed in table in unitary succession in region of extreme variates, only those for which there are entries being specified: PC and NPC data only recorded, TT values being obtainable, if required, by addition.

TABLE II.

G. (G.) attenuatus (Jenyns)

FREQUENCY DISTRIBUTION OF LS FOR PC, TT MATERIAL; $h = 1$ mm.

Length-Class (mm.)	No. of Individuals				Length-Class (mm.)	No. of Individuals				Length-Class (mm.)	No. of Individuals			
	LS		LT			LS		LT			LS		LT	
	PC	TT	PC	TT		PC	TT	PC	TT		PC	TT	PC	TT
31·5	—	1	—	—	69·5	2	3	11	18	107·5	—	4	—	1
32·5	—	—	—	—	70·5	2	10	7	10	108·5	—	4	—	3
33·5	3	4	—	—	71·5	6	10	6	7	109·5	—	4	—	11
34·5	3	6	—	—	72·5	5	7	5	10	110·5	—	1	—	3
35·5	16	20	—	1	73·5	2	7	6	10	111·5	—	4	—	4
36·5	21	25	—	—	74·5	2	5	5	6	112·5	—	3	—	4
37·5	28	42	1	1	75·5	2	6	3	6	113·5	—	2	—	1
38·5	45	59	1	2	76·5	2	5	4	4	114·5	—	4	—	3
39·5	64	83	3	3	77·5	1	5	1	5	115·5	—	1	—	3
40·5	66	81	8	13	78·5	1	5	4	7	116·5	—	1	—	3
41·5	52	66	16	19	79·5	3	6	—	4	117·5	—	1	—	1
42·5	55	70	25	37	80·5	3	6	2	6	118·5	—	—	—	3
43·5	57	65	40	51	81·5	2	8	4	8	119·5	—	1	—	6
44·5	42	48	63	79	82·5	1	8	8	11	120·5	—	2	—	1
45·5	39	60	43	58	83·5	1	4	2	5	121·5	—	—	—	4
46·5	35	46	61	81	84·5	2	4	—	4	122·5	—	1	—	3
47·5	30	43	50	57	85·5	1	1	3	4	123·5	—	3	—	3
48·5	23	44	47	56	86·5	2	4	2	9	124·5	—	2	—	4
49·5	30	50	44	57	87·5	1	4	1	5	125·5	—	—	—	2
50·5	24	36	39	43	88·5	2	5	1	2	126·5	—	2	—	2
51·5	28	41	34	47	89·5	1	6	1	3	127·5	—	—	—	3
52·5	21	33	27	39	90·5	3	6	2	6	128·5	—	—	—	1
53·5	25	35	30	41	91·5	—	2	2	4	129·5	—	—	—	3
54·5	15	24	27	39	92·5	1	3	4	7	130·5	—	—	—	3
55·5	10	21	16	32	93·5	—	4	1	9	131·5	—	—	—	3
56·5	17	26	26	45	94·5	—	2	—	4	132·5	—	—	—	1
57·5	19	31	22	32	95·5	—	9	2	4	133·5	—	1	—	—
58·5	15	22	26	40	96·5	—	5	1	3	134·5	—	—	—	1
59·5	12	16	19	28	97·5	—	4	1	1	137·5	—	—	—	1
60·5	10	17	26	36	98·5	—	6	1	3	138·5	—	—	—	2
61·5	13	17	15	26	99·5	—	2	3	5	139·5	—	—	—	1
62·5	5	8	13	23	100·5	—	5	1	6	140·5	—	—	—	2
63·5	5	8	11	21	101·5	—	3	—	3	143·5	—	—	—	3
64·5	3	10	15	24	102·5	—	2	1	6	145·5	—	—	—	1
65·5	10	11	15	27	103·5	—	3	—	2	151·5	—	—	—	1
66·5	4	6	15	20	104·5	—	6	2	2	172·5	—	1	—	—
67·5	2	5	12	14	105·5	—	3	—	4	185·5	—	1	—	—
68·5	2	6	9	13	106·5	—	2	1	4	192·5	—	—	—	1
										207·5	—	—	—	1

With $h = 1$, $M_{o_{LS}}$ for PC, NPC, TT material occurs in the following classes:—40·5 (66 cases); 45·5, 48·5 (each 21 cases); 39·5 (83 cases); $M_{o_{LT}}$ in 44·5 (63 cases); 46·5 (20 cases); 46·5 (81 cases), respectively.

For the investigation and the construction of histograms $h = 1$ gives too fine a grouping (note, *e.g.*, two values for $M_{o_{LS}}$ in NPC material above): results of employment of larger class intervals are discussed below.

PC Material. With $h = 3$, the 20 classes 34, 37..91 yield (f_{LS})=22, 94, 182, 154, 104, 77, 74, 42, 46, 28, 18, 8, 10, 9, 5, 7, 4, 5, 4, 4. Modal class is thus 40. Frequency histogram shown in Fig. 3. The curve is mesokurtic. The decrease in height of successive rectangles is not maintained in classes > 55. With $h = 5$, giving the 13 classes 32·5, 37·5..92·5, with (f_{LS}) giving 6, 174, 272, 157, 113, 73, 36, 20, 17, 9, 9, 10, 1, the right limb approximates closely to a smooth descending curve (Fig. 4). The PC histogram for LS with $h = 6$ is implicit in Fig. 5, where PC values are represented by stippled rectangles equivalent to TT – NPC: similarly for $h = 10$ in Fig. 6.

Examining the histogram for $h = 3$ (Fig. 3), we see the distribution has a marked positive skew. Using Pearson's approximate measure of skewness $S_k = \frac{3(\bar{x} - M_d)}{\sigma}$, we have $S_k = \frac{3(47{\cdot}94 - 43{\cdot}93)}{10{\cdot}45} = 1{\cdot}15$.

With $h = 3$, the 25 classes 34, 37..106 give $(f_{LT}) = 0, 2, 27, 128, 154, 130, 91, 69, 67, 54, 41, 36, 24, 16, 8, 6, 14, 5, 3, 8, 3, 3, 4, 3, 1$. Wit $h = 5$, the 16 classes 32·5, 37·5..107·5 give $(f_{LT}) = 0, 5, 152, 245, 157, 109, 80, 62, 29, 12, 16, 8, 9, 8, 4, 1$.

TT Material. This includes sufficient specimens, exhibiting an interval between extreme variates about 2·5 times that of PC material, to permit of the reasonably satisfactory use of a class-interval twice that employed in the case of PC. With $h = 6$, we have 26 classes, 32·5, 38·5..182·5 with $(f_{LS}) = 30, 356, 322, 239, 140, 71, 40, 35, 37, 24, 26, 25, 20, 18, 8, 8, 2, 1, 0, 0, 0, 0, 0, 1, 0, 1$. Modal class = 44·5. Histogram shown in Fig. 5 (total rectangles, both black and stippled portions). The curve, which does not exhibit successive decrease of (f_{LS}) in classes > 68·5, is more leptokurtic than that for PC material (Fig. 5, stippled areas). With $h = 10$ (Fig. 6), the 16 classes 35, 45..185 give $(f_{LS}) = 240, 573, 285, 91, 66, 50, 43, 36, 18, 10, 1, 0, 0, 0, 1, 1$, the histogram thus exhibiting continuous decrease of ordinate values between M_o (45 class) and 135 class, to the right of which occurs a hiatus of three classes, followed by two classes (175, 185) each with a single entry.

Using the approximate measure of skewness employed above, we find that the LS histogram of TT material yields $S_k = \frac{3(58{\cdot}81 - 46{\cdot}73)}{18{\cdot}86} = 1{\cdot}92$, the skewness being positive.

With $h = 6$, the 30 classes 32·5, 38·5..206·5 give $(f_{LT}) = 1, 38, 363, 283, 216, 157, 82, 41, 41, 27, 34, 21, 19, 26, 19, 17, 15, 3, 8, 1, 1, 0, 0, 0, 0, 0, 1, 0, 1$. With $h = 10$, the 18 classes 35, 45..205 give $(f_{LT}) = 7, 508, 386, 222, 69, 57, 46, 42, 31, 26, 12, 6, 1, 0, 0, 0, 1, 1$.

NPC Material. Since NPC = TT − PC, values for (f_{NPC}) for all classes of LS and TT here considered may be obtained from data above. Frequency distribution of NPC with $h = 6$, $h = 10$ is exhibited in Fig. 5 and Fig. 6, respectively (black areas). Within the LS and LT ranges in which NPC and TT differ (*i.e.*, range of PC), the former is irregular. NPC provides the most platykurtic curves of the three groups. For investigation of frequency distribution NPC is less significant than either PC or TT, partly from numerical inferiority, partly in view of the fact that only an insignificant portion of the material has been trapped.

For NPC material LS skewness (positive) is $S_k = \frac{3(63{\cdot}98 - 53{\cdot}89)}{25{\cdot}22} = 1{\cdot}20$.

Seasonal Variation in Frequency in Punchbowl Creek

As might be anticipated, an investigation of the seasonal variation in frequency provides interesting data regarding migration and rate of growth.

Material. Comprises 30 series from Punchbowl Creek, consisting of 897 specimens. Extends over a period of approximately three years, from 25th November, 1934, to 6th October, 1937, embracing four major vernal immigrations. To take in the vernal immigration of 1937 two additional series, not included in PC material, and thus not specified in Table I, are considered. These are Series 143 (sample W), Punchbowl Creek, *Larnoo* Section, 10 specimens, 26 9 37; for LS, min. 43·1, max. 85·6, $\bar{x}$ 65·4, Md 64·6, σ 11·09; for LT, min. 49·0, max. 92·0, $\bar{x}$ 72·9, Md 71·6, σ 11·53; Series 144 (sample X), Punchbowl Creek, *Larnoo* Section, 57 specimens, 6 10 37; for LS, min. 37·8, max. 75·0, $\bar{x}$ 46·9, Md 41·9, σ 9·45; for LT, min. 43·4, max. 85·4, $\bar{x}$ 53·8, Md 49·2, σ 10·73.

Method. Seasonal frequency polygons,[1] with frequency expressed as a percentage, are shown in Fig. 7, A—X, (f_{LS}) being represented

[1] The chief theoretical disadvantage of the frequency polygon as compared with the histogram, namely, its suggestion that all variates in a class are concentrated at the class-centre, may be regarded, for our present purpose of visual representation, as being rather a practical advantage than otherwise.

by an unbroken line. The most striking features of the distribution are best brought out with $h = 10$: the disadvantageous effects of the arbitrary incidence of such a coarse grouping are somewhat diminished by the graphing, in dotted lines, of (f_{LT}) as a percentage.

Detailed analyses of these series have been made, and have yielded some very interesting results: these are, however, too lengthy for inclusion here, and the following discussion is confined to a summary of the more striking features revealed.

Samples S, W, X, Y are from the *Larnoo* Section of the Creek. Samples P, Q, R, T, U, V are seven pairs of series collected on same day in *Larnoo* and Reserve Sections of Creek: in the case of such pairs, *Larnoo* series is graphed first, with suffix L (*e.g.*, P_L), followed first by Reserve series (P_R), and then by pooled result (P_P).

Migrations. The most conspicuous migration is a vernal one, occurring about October.[1] Samples taken at this time show mode in 35 class: dispersion is small, due to the predominance of the migrating juvenile population, the advent of which results in the greatest density of individuals in the Creek at any period of the year.[2]

In 1935 the vernal immigration occurred between 18th August and 8th October. Thus sample G, on the former date, shows a somewhat platykurtic curve, indicative of large dispersion ($\sigma_{LS} = 11{\cdot}86$, a value greater than σ_{LS} for whole PC material), and showing only moderately defined mode. Sample H, taken in October, includes the juvenile migration; mode is in 35 class; curve is leptokurtic; dispersion is small ($\sigma_{LS} = 4{\cdot}72$): note presence for first time of 35 1 T class (3%). LS min. for H is 33·5, *i.e.*, within 2·4 of the absolute min. for TT material, met with in Series 84, collected in Beattie's Creek, near mouth of Forth River, on 31st August, 1935, and almost certainly representing the same population sampled near the sea at the beginning of the long inland migration needed to bring fish from coastal waters to such a locality as Punchbowl Creek.

It may be noted that in this year the juvenile migration of *G.* (*G.*) *attenuatus* was accompanied by a migration of young *G.* (*G.*) *truttaceous*, 18 specimens of which, of LS 41·2–57·7, $\bar{x}$ 45·3, σ 3·29, accompany

[1] The date of arrival probably varies slightly in different years, being, for instance, liable to delay, extending perhaps over some days, when unusual freshes occur in the river.

[2] In general all immigrating post larvae appear in the Creek suddenly, apparently arriving more or less in what is virtually a single wave of invasion. Note, however, in sample W, specified above, an *LS* min. of 43·1, representing a single stray individual (next smallest specimen has *LS* 57·5) whose arrival has preceded by some days that of the main invasion recorded in sample X.

Series 89. In sample H also 33 young *G.* (*G.*) *attenuatus* were accompanied by 18 of *G.* (*G.*) *truttaceus* of LS 42·0 – 75.5, $\bar{x}$ 54.8, σ 8.10. Similarly, 43 specimens in sample M were accompanied by 4 *G.* (*G.*) *truttaceus* of LS 45·6 – 51·6, $\bar{x}$ 48·0, σ 2·23.

In 1936 the vernal immigration occurred between 4th and 10th October—see graphs L, M. Sample M, Series 115, clearly comprises three age-classes: (*a*) Nos. 1–39, young fish, just migrating; treated as a separate section, these have, as regards LS, min. 34·4, max. 42·3, $\bar{x}$ 39·5, σ 1·43; (*b*) Nos. 41–43, about one year old, having, as regards LS, min. 65·1, max. 65·6, $\bar{x}$ 65·3, σ 0·21; (*c*) No. 43; one individual of LS 90·1, three or four years old. The vernal immigration in 1937 is shown in sample X, taken on 6th October.

This is a typical sample for this month of the year. With $h = 1$, LS distribution is: $(f_{37\cdot5}) - (f_{49\cdot5})$ inclusive = 1, 3, 5, 6, 5, 9, 6, respectively; with thereafter one entry in each of the following classes: 55·5, 58·5, 61·5, 62·5, 64·5, 65·5, 67·5, 73·5, 75·5, and three entries in 60·5 class. Note density, with roughly symmetrical distribution, round 42·5 class (mode), with hiatus between 49·5 and 55·5 classes, the first 35 specimens being immediately post-larval, and the 55·5 representative a small one-year individual. Specimens (35) of classes 37·5–49·5, inclusive, have, as regards LS, min. 37·8, max. 49·8, $\bar{x}$ 42·4, Md 41·4, σ 2·63.

Sample A, 25th November, 1934, shows migrating population about one month after arrival, and corresponds approximately with sample N, taken approximately two years later: note that A and N differ from I, of virtually the same date in 1935, in having the LS mode advanced into 45 class, perhaps indicating less rapid growth in 1935.

A leptokurtic curve in D, with well-defined mode in 45 LS class, and a prominent mode in 35 LS class in R, would seem to indicate the occurrence of a second definite juvenile immigration in February or March.

It is just possible a third migratory movement inland occurs about June—compare T_P and U_P.

A comparison of the pairs of samples (P—U) taken on the same dates in the *Larnoo* and Reserve Sections suggests the likelihood of intra-creek movements of some importance taking place at times.

Turning next to the question of emigration, we find individuals of LS classes > 65 are absent from all samples taken in May, June, July, and from two-thirds of samples taken in February, April, November, December. Though such negative evidence cannot, of course, be relied upon, it seems clear from other considerations (*e.g.*, observations on spawning, to be noted in a future contribution) that sexually

mature fish normally emigrate from creeks and headwaters of rivers, descending to brackish or salt water to spawn, about April, and are absent till about June or July. It is not unlikely that a second emigration takes place about midsummer.

The migrations of *G.* (*G.*) *attenuatus* in New Zealand have been discussed by various authors. Hutton (1872, p. 60) was apparently the first to record its catadromous habit. Clarke (1899) observes it 'periodically descends to the sea in January, February, and March, where it spawns, returning in March, April, and May,' and adds 'the young begin to appear in the rivers sometimes as early as the end of June, but they definitely commence to arrive in August, the shoals increasing in size and number in September and October'. Best (1903) has given the Maori version of the movements of the *Inanga*, which speaks of three seaward migrations. The observations of these writers and others have been reviewed by Phillipps (1919), who concluded (p. 213): (*a*) 'it migrates from the streams and rivers to the sea between some date after midsummer until after autumn'; (*b*) 'whether three separate migrations can be distinguished or not remains yet to be proved'; (*c*) 'towards the end of winter the parent fish, which have spawned in the sea, return to fresh water'; (*d*) 'the young appear off the coasts in the early spring months . . .' and 'enter the rivers and streams around the coast until about the end of November'.

Growth. General trend of growth is well illustrated by, and may be examined in, samples A, B, C (Fig. 7), collected on successive months.

Fig. A represents a pure sample of a fairly juvenile population that has recently entered the creek: this stage is later than H, M, &c., and is still compact and of low $\bar{x}_{LS}$. Dispersion small; material wholly comprised in 35, 45, LS classes (LS extreme variates 36·1, 47·0; σ_{LS} 2·71 (minimum value of all samples is 24·8 in U_L below; while σ_{LS} of segregated juvenile population—39 individuals—of M is 1·43).

With $h = 1$, LS distribution is virtually symmetrical, $S_k = -0{\cdot}22$. Sample is unusual in having $Md_{LS} > \bar{x}_{LS}$. Data afforded by samples A-X, and *à fortiori*, that afforded by pooled NPC and TT material, suggest degree of positive skewness is a direct function of length of fish. (f_{LT}) for classes 35 - 95 = 0, 16, 5, 0, 0, 0, 0.

Sample B shows (slight) increase in LS, as compared with A, indicated in LS polygon by reduction (24-22 %) in (f_{35}), and increase (0-9 %) in (f_{55}), with concomitant reduction (76-68 %) in frequency of modal class (45). Increase in $\bar{x}_{LS}$ (here 43·8) is 1·4.

Less compact sample than A; LS extreme variates 36·5, 57·8; σ_{LS} increased to 5·43 (excluding three specimens of 55 class, $\sigma_{LS} = 2·7$ as in A); V_{LS} 12·4%. Slight negative asymmetry of A here becomes positive; $S_k = 0·39$.

$(f_{LT}) = 0, 19, 10, 3, 0, 0, 0$. Thus, in LT polygon, (f_{55}) has increased to 31% or > ½ modal frequency (59%), as against < ½ modal frequency in A; while (f_{65}), unrepresented in A, now accounts for 9% of sample.

In sample C positive lateral displacement of centre of gravity of polygon, indicative of general increase in length, continues. For LS, (f_{35}) has further decreased (to 6%), now being < ⅓ that in B; while (f_{55}) has increased (to 34%), being > ⅔ of modal frequency, as against < ½ in B, zero in A. Modal class (45) has dropped to 54%. $\bar{x}_{LS} = 48·7$, or 4·9 in excess of that of B: more significantly for comparison, by exclusion of 75 and 85 classes, $\bar{x}_{LS} = 46·6$, an increase of 2·8 over B.

Dispersion continues to increase, σ_{LS} now 8·10 (or, making C strictly comparable with B, by exclusion of 5 individuals of LS > 60, $\sigma = 5·44$). LS extreme variates 38·0, 81·9: note successive slight increase in min. LS in A, B, C (36·1, 36·5, 38·0)—max. LS (though here also exhibiting progressive increase) obviously not a similar criterion, in view of possible adventitious inclusion (as in present sample) of specimens referable to population of different Creek-age. V_{LS} 17·3%: coefficients of variability of A, B, C, thus approximately 1 : 2 : 3. Asymmetry positive, $S_k = 0·33$. $(f_{LT}) = 0, 29, 32, 20, 1, 2, 1$. In LT polygon, mode for first time enters 55 class — $(f_{55}) = 36·5\%$, slightly exceeding (f_{45}), which = 33%: $(f_{65}) = 26\%$, *i.e.*, nearly thrice that in B.

The progressive increase in amount of dispersion is strikingly shown by increased length of portion of $\bar{x}$-axis included in polygon. Excluding entries of LS > 65, and of LT > 75 (clearly referable to population of previous season, or seasons; hence for present purposes adventitious), we find in A, B, C the LS polygon embraces successively 2, 3, 4 abscissal units, and the LT polygon 3, 4, 5 units (here continuation of graph to zero abscissal value at both ends adds in each case one unit to number of units found in corresponding LS polygon).

Again in D, E, F, LS mode of D, which is in 45 class, advances to 55 class in E, and reaches a higher value in that class in F: H, I, J exhibit successive decrease (60·8, 47·2, 45·7) in (f_{35}), *i.e.*, LS modal class: LS mode of M (35) advances to next class in N: R, S, T show successive decrease in (f_{35}), which is LS modal class in R; &c.

As regards rate of growth, it is to be noted that $\bar{x}_{LS}$ of E exceeds $\bar{x}_{LS}$ of A, C by 13·1, 6·8 respectively. On evidence afforded by these means, daily rate of growth during 42 days between A and C is 0·15; during 63 days between C and E 0·11; during 105 days between A and E 0·13.

It would appear that in Punchbowl Creek, under normal conditions, the relationship of LS to Creek-age is somewhat as follows. Great majority of immigrating juvenile population arriving about October have LS 35-45, with $\bar{x}_{LS}$ approximately 40. By the end of the first summer the dominant LS is about 60 ± 5. During the winter, growth is virtually suspended (note winter-intervals F-G, S-V in Fig. 8): three individuals (Series 141, 142, Punchbowl Creek, 10 9 37; not included in PC material) taken at the end of the 1937 winter have LS 56·0, 59·7, 69·8, x 61·8. In their second year of Creek-age, these fish normally enter the 70-80 LS class; while specimens of LS > 80 are probably in most cases in at least their third season. Young fish invading the Creek near the end of summer, in February or March, enter on their first spring in the Creek with LS < 50.

While the investigation of migration and growth by the segregation of material into length-classes, as above, is more effective and reliable than by the consideration of mean-length graphs, in which the chance inclusion in, or exclusion from, the material of a few individuals of large LS exercises a marked influence, nevertheless, in the present instance, owing to the numerical dominance of small individuals in samples taken at peak-periods of juvenile immigration, the $\bar{x}_{LS}$ graph has a definite value in summarizing the results of collection over about three years, and also, to some extent, in corroborating the results arrived at in the preceding analysis. The $\bar{x}_{LS}$ graph is shown in Fig. 8: the occasional occurrence of successive intervals greater than one month is attributable to unfavourable conditions for collection of samples (*e.g.*, drying-up of Creek in December, 1935).

Attention has already been called to the fact that in A, B, C dispersion increases with increased LS. As greater Creek-age provides occasion for greater individual variation in size, σ_{LS} is in general an index of $\bar{x}_{LS}$. The dispersion graph is shown side by side with mean-length graph in Fig. 8. It is seen the graphs tend to follow the same general course.

Features of special interest and apparent anomalies in Fig. 8 include: (*a*) troughs α_1 - α_4 indicating vernal juvenile immigrations; (*b*) troughs β_1 (β_2 not recorded), β_3 (the latter exhibited by R_R only, the locations of the co-ordinates of which for $\bar{x}_{LS}$ and σ_{LS} are shown by arrows leading from the general graphs), showing autumn juvenile immigration; (*c*) almost horizontal line for $\bar{x}_{LS}$ during winter months; (*d*) apparent anomaly of peak of σ_{LS} at R, due to pooling of R_L and R_P (*cf.* Fig. 7); (*e*) low values of σ_{LS} during 1937 winter (*e.g.*, T, U), accounted for by combined effects of March juvenile immigration and winter spawning emigration.

Variation of Proportions with Growth

(*a*) *Material.* Material measured, comprising 300 individuals, is specified as regards series (hence, also locality and date), and number of individuals in length-classes (with $h = 10$) in Table III. It has not been found practicable to make length-classes numerically equal; and it is probable that in the growth-curves discussed below data lying within the limits $35 \leq LS \leq 105$ (which approximately corresponds with Creek-range) are statistically more significant than data relating to classes with $LS > 105$ (note, in passing, omission in Table III of classes 145, 155, 165).

Table III

G. (G.) attenuatus (Jenyns)

Specification of Series for Variation of Proportions With Growth

Series No.	No. of Individuals Length-Classes of LS													
	35	45	55	65	75	85	95	105	115	125	135	175	185	Total
13	—	—	1	—	4	2	4	3	2	—	—	—	—	16
14	—	—	—	1	—	4	5	—	—	—	—	—	—	10
15	—	—	1	—	2	2	2	2	—	—	—	—	—	9
45	6	15	—	—	—	—	—	—	—	—	—	—	—	21
58	—	—	—	—	—	—	—	—	—	—	—	1	1	2
61	6	27	6	1	3	—	—	—	—	—	—	—	—	43
70	1	13	17	13	3	1	—	—	—	—	—	—	—	48
73	2	10	12	2	—	3	—	—	—	—	—	—	—	29
74	—	13	9	2	1	—	—	—	—	—	—	—	—	25
76	—	—	—	—	—	—	1	2	2	1	—	—	—	6
81	—	4	3	1	3	—	—	—	—	—	—	—	—	11
86	—	3	4	1	1	—	—	—	—	—	—	—	—	9
106	—	—	14	4	2	—	—	—	—	—	—	—	—	20
110	—	—	—	—	5	2	7	11	7	7	1	—	—	40
114	—	—	3	4	3	1	—	—	—	—	—	—	—	11
Total	15	85	70	29	27	15	19	18	11	8	1	1	1	300

(*b*) *Dimensions.* The following nine dimensions have been determined for these 300 specimens (Table IV): standard length, length to origin of dorsal fin, length to origin of pelvic fin, depth of body (maximum), length of caudal peduncle, depth of caudal peduncle (minimum), length of caudal fin, length of head, horizontal diameter of eye. Implicit in these dimensions are also total length (LS + length of caudal), length to origin of anal fin (identical, in this species, with length to origin of dorsal), base of anal fin (LS− [length to anal + length of caudal peduncle]), approximate length of trunk and of tail (since length to dorsal = length to anal = approximate length to vent), &c.

TABLE IV.

G. (G.) attenuatus (Jenyns)

DIMENSIONS OF 300 INDIVIDUALS.

Dimension		35	45	55	65	75	85	95	105	115	125	135	175	185
Standard Length (LS)	Min.	36·0	40·0	50·1	60·3	70·0	80·5	90·8	100·8	110·3	120·1	133·8	172·0	185·0
	Max.	39·9	49·9	59·9	68·5	79·9	89·9	99·9	114·5	119·9	126·5	133·8	172·0	185·0
	Md.	39·0	45·0	54·3	63·0	72·1	84·6	95·8	106·0	113·0	123·6	133·8	172·0	185·0
	$\bar{x}$	38·9	45·2	54·3	63·6	73·6	85·0	95·5	105·2	113·4	123·7	133·8	172·0	185·0
	σ	1·3	2·9	2·7	2·4	2·8	3·1	2·6	4·0	2·7	1·9	0·0	0·0	0·0
Length to Dorsal Fin	Min.	26·1	28·5	35·9	44·6	52·0	61·5	70·0	75·0	83·0	93·6	116·6	136·0	139·0
	Max.	31·5	39·0	48·5	52·0	60·0	68·2	75·5	88·0	93·0	98·2	116·6	136·0	139·0
	Md.	28·7	33·0	40·5	47·9	55·0	63·5	72·6	80·2	86·0	95·8	116·6	136·0	139·0
	$\bar{x}$	28·7	33·5	41·0	47·8	56·8	62·9	72·6	81·0	86·6	95·7	116·6	136·0	139·0
	σ	1·3	2·5	2·6	2·1	2·7	3·1	1·8	2·9	2·6	1·6	0·0	0·0	0·0
Length to Pelvic Fin	Min.	16·5	18·0	21·0	28·2	31·5	38·0	43·5	45·0	50·7	56·2	64·5	82·0	90·0
	Max.	19·5	24·0	29·0	34·0	39·6	44·0	48·5	54·0	56·0	63·0	64·5	82·0	90·0
	Md.	18·0	21·0	26·0	30·0	35·5	40·6	46·0	51·0	54·0	59·2	64·5	82·0	90·0
	$\bar{x}$	18·1	21·2	26·1	30·4	35·3	40·8	45·9	50·2	53·9	59·4	64·5	82·0	90·0
	σ	0·8	1·5	1·7	1·3	1·8	1·6	1·5	2·8	1·5	2·0	0·0	0·0	0·0
Depth of Body	Min.	3·1	2·2	5·0	7·0	8·0	10·0	10·6	12·8	13·1	16·0	21·5	30·0	36·0
	Max.	4·1	6·8	9·0	10·0	12·1	14·5	18·9	17·3	18·6	20·5	21·5	30·0	36·0
	Md.	4·0	4·8	6·5	8·2	10·1	12·0	13·8	15·5	15·5	19·3	21·5	30·0	36·0
	$\bar{x}$	4·0	5·1	6·7	8·4	9·9	12·3	13·8	15·6	16·0	19·2	21·5	30·0	36·0
	σ	0·3	1·2	0·7	0·9	0·9	1·2	1·8	1·2	1·8	1·4	0·0	0·0	0·0
Length of Caudal Peduncle	Min.	4·0	4·0	5·0	6·0	6·8	6·6	8·6	9·0	10·3	11·5	15·1	20·0	26·0
	Max.	5·5	6·1	7·5	7·6	9·1	9·5	11·9	11·6	13·2	14·5	15·1	20·0	26·0
	Md.	4·8	5·1	6·2	6·6	7·7	8·5	9·4	10·5	11·1	12·6	15·1	20·0	26·0
	$\bar{x}$	4·7	5·1	6·2	6·8	7·9	8·5	9·6	10·5	11·1	12·9	15·1	20·0	26·0
		0·5	0·4	0·5	0·5	0·6	0·8	0·8	0·5	0·3	0·9	0·0	0·0	0·0

TABLE IV—*continued*

G. (G.) attenuatus (Jenyns)

DIMENSIONS OF 300 INDIVIDUALS

Dimension		35	45	55	65	75	85	95	105	115	125	135	175	185
Depth of Caudal Peduncle	Min.	1·5	1·8	2·3	2·8	3·9	4·5	5·2	5·5	5·8	6·6	8·3	13·5	15·0
	Max.	4·0	3·4	4·0	4·5	5·6	5·8	6·5	8·6	8·0	8·6	8·3	13·5	15·0
	Md.	2·1	2·5	3·1	3·6	4·4	5·0	5·6	6·3	6·7	7·5	8·3	13·5	15·0
	$\bar{x}$	2·2	2·4	3·1	3·7	4·5	5·1	5·8	6·5	6·8	7·5	8·3	13·5	15·0
	σ	0·7	0·3	0·4	0·5	0·4	0·3	0·4	0·7	0·5	0·6	0·0	0·0	0·0
Length of Caudal Fin	Min.	4·5	4·2	5·3	6·1	8·9	8·4	10·2	12·7	14·0	16·5	17·7	20·0	22·0
	Max.	6·5	8·8	12·0	10·5	11·5	12·8	15·5	16·5	17·5	21·0	17·7	20·0	22·0
	Md.	5·5	6·5	8·0	9·0	10·2	11·5	13·4	15·0	15·5	17·3	17·7	20·0	22·0
	$\bar{x}$	5·6	6·5	7·9	9·0	10·5	11·5	13·3	14·7	15·7	17·9	17·7	20·0	22·0
	σ	0·5	0·9	0·9	0·8	0·6	1·0	1·2	0·3	1·1	1·4	0·0	0·0	0·0
Head	Min.	6·4	6·0	8·2	10·2	11·8	12·5	15·3	16·3	17·5	18·0	21·0	29·0	31·0
	Max.	8·0	10·0	11·5	13·0	18·3	15·3	17·5	19·2	21·1	21·0	21·0	29·0	31·0
	Md.	7·0	8·0	9·7	11·2	12·9	14·1	16·0	17·8	18·5	19·5	21·0	29·0	31·0
	$\bar{x}$	7·1	8·1	9·8	11·3	13·5	14·1	16·2	17·8	18·8	19·4	21·0	29·0	31·0
	σ	0·5	0·7	0·7	0·8	1·4	0·7	0·7	1·6	1·0	0·7	0·0	0·0	0·0
Eye	Min.	2·0	2·0	2·1	2·6	2·6	3·0	3·5	3·7	3·9	4·1	4·1	5·5	6·0
	Max.	2·5	2·9	3·1	3·4	3·9	3·8	4·5	4·5	5·0	4·7	4·1	5·5	6·0
	Md.	2·1	2·5	2·8	3·0	3·3	3·5	3·9	4·1	4·3	4·4	4·1	5·5	6·0
	$\bar{x}$	2·2	2·5	2·7	3·0	3·3	3·4	3·9	4·2	4·3	4·4	4·1	5·5	6·0
	σ	0·2	0·2	0·2	0·2	0·3	0·2	0·2	0·2	0·3	0·2	0·0	0·0	0·0
No. in Class		15	85	70	29	27	15	19	18	11	8	1	1	1

Growth-Curves

Growth-curves with length to dorsal, length to pelvic, depth of body, length of caudal peduncle, depth of caudal peduncle, head, eye, length of caudal, plotted as ordinate against actual $\bar{x}_{LS}$ (not mid-points of LS class) of classes 35, 45 .... 135, 175, 185 as abscissa are shown in Fig. 9, A–H: while eye in head and depth of caudal peduncle in its length are shown in Fig. 11, A, C, and these two body-ratios are also plotted against $\bar{x}_{LS}$ as abscissa in Fig. 9, I, J.

It is found that most of these curves yield approximations to straight lines when treated logarithmically: these are replotted in Fig. 10, A–J, the ordinate being the logarithm of mean value of dimension or ratio, and the abscissa log $\bar{x}_{LS}$. Logarithmic equivalents of Fig. 11, A, C are shown in Fig. 11, B, D.

The use of a double logarithmic grid is of considerable interest in showing that some regions of the body—*e.g.*, length to dorsal, length of caudal peduncle, depth of caudal peduncle—show increase in absolute size with absolute size (measured by LS) of the fish as a whole (heterogony). The results of Hecht (1916), quoted by Huxley (1932, p. 38), show long-continued isogony (organ, or region, growing at same rate as organism) in all measured dimensions in fish; but Huxley points out that the work of Keys (1928), who finds that in herrings, sardines, and *Fundulus* the weight increases faster than the cube of length, which implies form-change, and results obtained by Hickling (1930) for *Acanthias vulgaris* Risso and by Shaw (1931) for *Paracheilognathus* indicate that Hecht's assumption of form-constancy in teleosts is not strictly true. The present observations would seem clearly to indicate the general occurrence in *G.* (*G.*) *attenuatus* of simple heterogonic growth, usually not far removed from isogony, possibly also of 'non-simple' (*e.g.*, exponential) heterogonic functions—results of immediate and practical value in the systematics, and of interesting implications in the general biology, of the group.

(*a*) *Length to Dorsal on* LS. Direct plotting of means in Fig. 9, A; logarithmic plotting in Fig. 10, A. Length to dorsal is positively heterogonic [increasing in relative size with growth (Huxley, 1932, p. 17)]. Applying Huxley's simple heterogony formula, $y = bx^{k}$[1] [x

[1] This use of k implies that the ratio of relative growth-rate (= rate of growth per unit weight, *i.e.*, actual absolute growth-rate at any instant divided by actual size at that instant) of organ to relative growth-rate of body remains constant (through range over which formula holds), the ratio itself being denoted by the value of k. This is at once seen by plotting log y against log x. In unit time increase in log y is k times increase in log x,

$$i.e., \frac{d}{dt} \log y = k \frac{d}{dt} \log x$$

is magnitude of organism, *i.e.*, here = LS; b is a constant, the fractional coefficient, which merely denotes the value of y when $x = 1$, and is for our present purpose of no particular biological significance; k is a constant, the growth-coefficient of the organ, denoting a constant differential growth-rate], we have for the straight line passing through the points for the 35 and 125 classes, which affords a good approximation to the general linearity of the graph, $y = 0{\cdot}63\ x^{1{\cdot}04}$. Growth-coefficient is thus 1·04.

(*b*) *Length to Pelvic on* LS. Direct plotting in Fig. 9, B; logarithmic plotting in Fig. 10, B. The ratio is nearly isogonic. Its equation in the form $y = ax + b$, which Scammon employs extensively in his

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$$\text{or } \frac{dy}{dt} \Big/ y \qquad = k \frac{dx}{dt} \Big/ x$$

The prime merit of Huxley's formula, as compared with certain arbitrary formulae employed by other investigators—*e.g.*, $y = mx + c$, which holds true only for isogonic growth, isogony being merely a particular case of heterogony, as the circle is a special case of the ellipse; and which affords a useful approximation only while the value of the growth-coefficient does not markedly depart from unity—resides in the fact that it may be directly deduced (Huxley, 1932, p. 6) from certain fundamental principles of growth in general.

Three fundamental facts concerning growth are: (1) it is a process of self-multiplication of living substance, *i.e.*, rate of growth of an organism growing equally in all its parts is at any moment proportional to size of organism; (2) rate of self-multiplication decreases with increasing age (size); (3) rate is influenced by external environment. Now (2) and (3) affect all parts of body equally; hence we may assume the growth-rate of a given organ is proportional simultaneously, (*a*) to a specific constant characteristic of organ, (*b*) to size of organ at any instant, (*c*) to a general factor dependent on age and environment, which is the same for all parts of the body.

Hence when y stands for size of organ, and x for size of rest of body, while α, β are specific constants for rest of body, organ, respectively, and G measures general conditions of growth as affected by age and environment, we have

$$\frac{dx}{dt} = \alpha x G \text{ and } \frac{dy}{dt} = \beta y G,$$

$$\text{hence } \frac{dy}{dx} = \frac{\beta y}{\alpha x},$$

$$\text{or } \log y = \frac{\beta}{\alpha} \log x + \log b \quad (b \text{ being a constant})$$

$$\text{i.e., } y = b x^{\frac{\beta}{\alpha}}$$

in which $\frac{\beta}{\alpha}$ is a constant, denoted by k, the growth-coefficient, or ratio of the specific components of growth-rates of y and x respectively.

Since the simple heterogony formula can be written $\log y = \log b + k \log x$, magnitudes obeying the formula fall along straight lines when plotted on a double logarithmic grid.

important work on the growth of the human foetus (references in Scammon and Calkins, 1929), is $y = 0{\cdot}49x—1{\cdot}06$. The graph very nearly passes through the origin, and accordingly the length to pelvic-LS ratio is approximately constant, its value from the equation above being 0·49, or, calculated direct from mean of length to pelvic and $\bar{x}_{LS}$ for 300 specimens, 0·478.

The location of pelvic-root relative to tip of snout and hypural joint has customarily been invested with great taxonomic significance among the Galaxiidae, and is one of the characters employed by Regan (1906, p. 369) in differentiating between South American, New Zealand, and Australian races of *G.* (*G.*) *attenuatus* (Jenyns). These observations tend to confirm its value as a diagnostic character, used in this way, in the present species. A few general observations, which need, however, to be substantiated by more extensive measurements, suggest the ratio may not have equal diagnostic significance in all species of the genus—*cf.* remarks (Scott, 1936, p. 100) on *G.* (*G.*) *parkeri* Scott.

With logarithmic plotting (Fig. 10, B), $y = 0{\cdot}421\ x^{1{\cdot}027}$.

(*c*) *Depth of Body on* LS. Direct plotting in Fig. 9, C: logarithmic plotting in Fig. 10, C. Growth is heterogonic. Best straight line gives $y = 0{\cdot}022x^{1{\cdot}414}$, the growth coefficient thus being fairly high (1·414). These results are in marked contrast to those of Hecht for the teleost *Orthopristis chrysopterus*, his graph of maximum depth on total length (range of latter 4-24 cm.) showing with direct plotting a straight line, the equation of which, determined from his figure, is $y = 0{\cdot}25x$.

(*d*) *Length of Caudal Peduncle on* LS. Direct plotting in Fig. 9, D; logarithmic plotting in Fig. 10, D. Direct plotting of means of length of caudal peduncle against means of LS gives a markedly curvilinear graph, and plotting of logarithms of means still leaves graph clearly curved, this ratio thus differing from those hitherto considered.

The results could be interpreted by regarding Fig. 10, D as consisting of two sections, the first (LS 38·93—113·39) having a growth-coefficient of about 0·80, and the second (LS 113·39—185·0) a growth-coefficient of about 1·73. Such a state of affairs, in which a constant differential growth-rate is maintained during part of the life of an organism, being preceded or succeeded at a given period (usually at a definitive phase of its history, *e.g.*, onset of heterogony of large chela at first or second instar of post-larval life in the crab *Uca pugnax*; isogony followed by heterogony, probably at sexual maturity, in chelae of the spider crab *Maia squinado*, &c.) by isogony or by heterogony of a different magnitude, is by no means unknown. An inspection of

Figs. 9, 10 reveals, indeed, in more than half the curves illustrated a more or less marked indication of a change of slope occurring at about LS 125, which is not improbably the approximate length of normal maturity.

An alternative method of attack is indicated by the suggestion in Fig. 9, D of a curve of the exponential family. The equation $y = b\,e^{kx}$ appears to provide the best fit. Exponential plotting yields a fair approach to linearity, the graph, though somewhat irregular, showing no marked general predominance of positive or negative ordinal values. Best straight line is $y = 1{\cdot}109e^{-2{\cdot}26x}$.

(*e*) *Depth of Caudal Peduncle on* LS. Direct plotting in Fig. 9, E; logarithmic plotting in Fig. 10, E. Through approximate Creek-range (first 8 x-points) double logarithmic plotting gives a remarkably close approximation to a straight line, indicating simple heterogony, with growth-coefficient $k = 1{\cdot}117$ ($y = 0{\cdot}036\,x^{1{\cdot}117}$). The interpretation of the curve to the right of LS = 105·2 is doubtful.

(*f*) *Head on* LS. Direct plotting in Fig. 9, F; logarithmic plotting in Fig. 10, F. Best straight line for Fig. 10, F is $y = 0{\cdot}240\,x^{0{\cdot}928}$. Hence, growth is nearly isogonic, as is also evident from Fig. 9, F, the approximate equation for which is $y = 0{\cdot}165\,x + 0{\cdot}62$: graph very nearly passes through the origin; and hence head-in-LS is approximately constant, its value, calculated direct from the mean length of head and $\bar{x}_{LS}$ for 300 specimens, being 0·173.

(*g*) *Eye on* LS. Direct plotting in Fig. 9, G; logarithmic plotting in Fig. 10, G. Graph shows a point of inflexion in 85 class; probably not significant. Simple heterogony equation is $y = 0{\cdot}288\,x^{0{\cdot}564}$.

(*h*) *Length of Caudal on* LS. Direct plotting in Fig. 9, H; logarithmic plotting in Fig. 10, H. Over normal range of LS, plotting on a double logarithmic grid yields a good approach to a straight line, the approximate equation of which is $y = 0{\cdot}170\,x^{0{\cdot}956}$.

(*i*) *Eye on Head.* Direct plotting in Fig. 11, A; logarithmic plotting in Fig. 11, B. From direct plotting, which yields a very fair degree of linearity, we have $y = 0{\cdot}187\,x + 0{\cdot}833$. Double logarithmic plotting gives a rather markedly curvilinear graph with a k-value of about 1·6.

The ratio eye-in-head, which is a recognized diagnostic criterion among the Galaxiidae, is plotted against LS directly in Fig. 9, I; on a double logarithmic grid in Fig. 10, I.

(*j*) *Depth of Caudal Peduncle on Length of Caudal Peduncle.* Direct plotting in Fig. 11, C; logarithmic plotting in Fig. 11, D. Note the suggestion of the existence of two cycles of growth, the first ending, the second beginning, at the 125 LS-class. For the graph as a whole, k is approximately 1·0.

Results of plotting the ratio depth-of-caudal-peduncle-in-its-length against LS directly, logarithmically, are shown in Fig. 9, J, Fig. 10, J, respectively. In both cases the curves are concave—a fact not very obvious in Fig. 9, J: on replotting with the ordinate scale multiplied, say, tenfold, the greater part of the curve superficially suggests a catenary—and have a general negative slope. Though the ratio depth-of-caudal-peduncle-in-its-length is customarily noted in specific diagnosis in the genus *Galaxias*, it is, in general, not a very significant character, inasmuch as, in the first place, its value varies, as here demonstrated, with length-of-fish (Regan's revision of the family records a variation of 50%, or more, in the value of the ratio in the case of some species), and, in the second place, its mean value is in few species markedly different from its mean values in allied forms.

Growth-Gradients: Axial Growth-Potential

Huxley (1932), who has extended and generalized the conceptions of regional differential growth formulated by D'Arcy Thompson (1917) and others, and has in part subjected the problems involved to quantitative analysis, has plotted growth-coefficients of successive regions of an organ as ordinates at equal arbitrary intervals along the x-axis, and thus obtained a curve representing the distribution along the organ of *growth-potential*. Such a curve is a graphic representation of a *growth-gradient* within the organ, the inclination of the curve to the horizontal representing the steepness of the gradient, or in other words the difference in absolute growth-potential between the two ends of the gradient (as measured by growth-coefficients, which for the present purpose afford the only comparable standard for measuring intensity of growth-potential in a number of different regions) in relation to length of gradient—*i.e.*, relative length of organ (Huxley, 1932, pp. 80-81).[1]

The method obviously may be extended to cover the graphing of growth-gradients along the axial line of an organism to show the general distribution of growth-potential in the animal as a whole; and some work on teleosts along these lines has been done by Huxley (1931), Ford (1930, 1931), and others.

[1] Some formal difficulties are discussed by Huxley (1932, p. 81). Note, for instance, that if y be value (say, linear measurement) of organ as a whole, and if y_1, y_2 . . . yn be the corresponding values of its constituent regions, then if $y = bx^k$ be a correct expression for the organ as a whole, then $y_1 = b_1x^{k_1}$, $y_2 = b_2x^{k_2}$, and so on, cannot be accurate expressions for the separate parts (or *vice versa*), since the sum of the several expressions for the parts will not exactly fit the expression for the whole: nevertheless, within certain limits of the value of k, the discrepancy will be only slight, and the use as above of growth-coefficients as standards of growth-intensity gives a close approximation to the truth.

In the present case, we may proceed caudad from the tip of the snout, distinguishing the following successive regions: (α) tip of snout to posterior margin of operculum (= length of head); (β) thence to insertion of root of pelvics (= head – pelvic interspace); (γ) thence to origin of dorsal (= pelvic – dorsal interspace, identical in *G.* (*G.*) *attenuatus* with pelvic – anal interspace); (δ) thence to end of base of anal (= anal base; calculated below from [LS – length of caudal peduncle] – length to origin of dorsal); (ε) thence to hypural joint (= length of caudal peduncle); (ζ) thence to posterior tip of outspread caudal fin (= length of caudal).

In the following analysis of the axial growth-potential we shall confine our investigations to the first eight length-classes in Table IV, covering LS 38·93–105·21 (*i.e.*, approximately Creek-range) and comprising 278 specimens.

Calculating the values for the six regions $\alpha - \zeta$ from data in Table IV, plotting results on a double logarithmic grid, and finding for the best straight line in each case its equation in the form of the simple heterogony formula, $y = bx^k$, we get the following growth-coefficients: $k_\alpha = 0{\cdot}95$, $k_\beta = 1{\cdot}09$, $k_\gamma = 1{\cdot}03$, $k_\delta = 0{\cdot}86$, $k_\varepsilon = 0{\cdot}75$, $k_\zeta = 0{\cdot}97$.

Axial growth-potential of *G.* (*G.*) *attenuatus* for LS 38·93 – 105·21 is shown in Fig. 12 (solid line).

Most important features are: (*a*) graph is a smooth curve (this appears to be a characteristic feature of growth-gradients in general, judging by cases cited by Huxley); (*b*) the highest point of the gradient, the *growth-centre*, occurs at β, sloping away for regions cephalad and caudad of the head-pelvic interspace, with a change of sign of gradient occurring at the region of the caudal fin; (*c*) regions in descending order of magnitude of their growth-coefficients are $\beta, \gamma, \zeta, \alpha, \delta, \varepsilon$; (*d*) for regions $\alpha, \beta, \gamma, \zeta$ coefficients closely approach unity, indicating that growth in these regions is nearly isogonic, the most markedly heterogonic regions being ε, followed by δ.

If we assume the end-classes (35, 105) are typical (*i.e.*, solve for each region, $y = bx^k$ for $x = 38{\cdot}93$, $x = 105{\cdot}21$), we get the distribution of growth-potential along the body-axis shown in Fig. 12 (dotted line). We find that in this particular case of the general expression of growth-gradient the sequence in descending order of magnitude of the growth-coefficients is $\beta, \gamma, \zeta, \alpha, \delta, \varepsilon$, as before, the values for γ, δ, and ε showing slight increases, that for α a slight decrease, and those for β and ζ being unchanged.

Viability Out of Water

It is well known that several of the Galaxiidae may survive for considerable periods out of water, a celebrated case, of course, being that of *Neochanna apoda* Günther, the type specimen of which was obtained

in stiff clay 4 feet below the surface (Günther, 1867). Hall (1901) and Fletcher (1906) [1] have recorded Tasmanian Galaxiids found in damp earth. See also observations of Phillipps (1926, p. 532) on survival of *Saxilaga* (*Lixagasa*) *burrowsius* and those of Scott (1934) on *S.* (*S.*) *cleaveri* (Scott) and on *G.* (*G.*) *truttaceus* Cuvier. Some observations of survival out of water in the laboratory—the first, so far as I am aware, dealing with extra-aqueous survival of *G.* (*G.*) *attenuatus*—are recorded below.

(*a*) *Material.* Series 11, 61, 70, 73, 114, 119, comprising 154 specimens. These series are specified in Table I, except in the case of Nos. 11, 1-7 (Punchbowl Creek: not trapped, and hence not included in PC material), which series has, as regards LS, min. 45·0, max. 101·5, $\bar{x}$ 77·8, Md 82·4, 10 mm. modal class 85, 105 (each 2 cases), σ 2·09.

(*b*) *Method.* Specimens used in these investigations were taken from their vessel, drained of their surplus water by being placed for a short time in an ordinary hemispherical household strainer with large mesh, and introduced into a dry enamel bucket, where they were examined at convenient intervals, half-hourly inspections being made where practicable.

(*c*) *Behaviour.* As a rule, the fish remain quite lively for many hours, jumping at intervals 3-4 inches straight up into the air, or slithering a similar distance up the side of the bucket. Respiration is noisy, especially in the earlier stages, the clicking sound caused by the movements of the operculum, mingled with the light thud made by the descent of a leaping fish, being in the case of a large series almost continuous. An upright posture, with the ventral surface resting squarely on the bottom of the vessel, is commonly maintained, especially in the earlier stages of exposure. No. 5 of Series 70, LS 61·8 mm., had swallowed 44 mm. of an earthworm 47 mm. long prior to the beginning of the experiment: this individual survived exposure for 1·5 hours.

(*d*) *Rate of Respiration.* The initial rate of respiration, about 58 per minute, decreases to 43-46 after five hours, and to about 35 after nine hours.

(*e*) *Duration of Survival.* Maximum duration of survival out of water in trials A-F respectively = 21·25, 25·0, 11·5, 20·0, 25·5, 12·5 hours, giving crude average of 10·7, or weighted average of 8·6. Survival of 10 hours or more is recorded in 46·1% of individuals, of

[1] Specimens obtained at West Strahan, Tasmania, by Miss M. Lodder; dug up in damp soil remote from any water. Fletcher states Stead examined the specimens, and reported that 'with some reservation they might perhaps be referred to *Galaxias truttaceus* Cuv. & Val.'. I am inclined, however, to believe they are probably not referable to *Galaxias* Cuvier at all, but to *Saxilaga* Scott.

20 hours or more in 6·5 %. It seems fairly evident that the external conditions of the experiment largely influence the survival-duration, the most important factors probably being temperature, atmospheric humidity, and time of day (evidence suggests viability is markedly greater at night [1]); intrinsic factors are discussed below.

Data are adequately summarized in Fig. 13, in which elapsed time in hours is plotted against number of surviving individuals. The curve M (dotted line) is an approximate generalized curve, in which weighted means of ordinates of A-F (numbers of surviving individuals) are plotted at abscissal intervals of 2·5 hours. As A-F are not strictly comparable one with another, owing to variation in external conditions in the six trials, M cannot be accepted as a precise representation of the survival curve; but it is of interest as an approximate indication of the general form that the individual curves A-F are seen, on smoothing, to approach.

(*f*) *Survival-Sequence a Function of* LS. Arranging the specimens in the order, from first to last, in which they succumb, and allotting a number, the survival-sequence number, N_S, to them, in accordance with their position in this series, we are led to the interesting conclusion that, on the average, $N_S \propto LS$.

In Fig. 14 the curves A-F exhibit LS plotted against N_S. In the majority of cases, despite marked individual fluctuation, the general tendency of LS to increase with N_S is quite evident. An attempt is made in Fig. 14 M to obtain a generalized result for A-F: the six curves have been plotted on the same abscissal interval, and the weighted means of the ordinates (LS) are exhibited in the present graph.

For pooled results shown in Fig. 14 M we have $\bar{x}_{LS}$ for successive quarters to succumb, respectively, 50·38, 50·56, 54·90, 61·74, crude; or 42·50, 43·01, 45·88, 51·32, when weighted for size of samples. Thus approximately LS is an index of N_S.

(*g*) *Survival-Duration and* LS. Since the external conditions of the trials, which so far have not been found susceptible of precise measurement, so largely determine the duration of survival of any given series of individuals, we cannot obtain any precise quantitative expression of the relation between survival-duration and LS that will

[1] Trials A-F were begun at 5.22 p.m., 5.53 p.m., noon, 3.35 p.m., 5.30 p.m., 9.40 a.m., respectively. Trials C and F, begun at noon or in forenoon, give crude average period of survival 7·0 hours, or weighted average of 5·3. Trials A, B, D, E, begun in afternoon, give corresponding values of 12·5, 11·0.

hold good beyond the limits of a single trial.[1] For the four successive quarters of samples A-F pooled, weighted time (total) is 19·1, 63·3, 91·7, 105·4 hours, respectively.

(*h*) *Other Intrinsic Survival-Factors.* After the experiments had been in progress for some time, it was observed that early mortality appeared to be more common among specimens with light ground-colour than among darker individuals. A record kept for 111 individuals suggests that general intensity of ground-colour is probably a minor factor determining extra-aqueous viability; but the present data do not provide adequate grounds for a satisfactory conclusion on the matter.[2] The question of a possible connection between viability and sex has not been investigated.

(*i*) *Survival Under Natural Conditions.* It is thus seen that even under rather rigorous laboratory conditions *G.* (*G.*) *attenuatus* is capable of surviving without external water for considerable periods. It seems, therefore, not unlikely that in a state of nature this species may at times weather short periods at least of partial drought, probably in a moist or humid environment.

(*j*) *Aestivation.* Reports received from time to time suggest *G.* (*G.*) *attenuatus* may upon occasion temporarily aestivate, when the drying-up of small watercourses with such celerity as to preclude the possibility of quick migration presents it with the alternatives of doing so or perishing. So far, however, all attempts I have made personally, by digging in the beds and banks of streams subject to sudden aridity, to find specimens actually imbedded in moist soil have yielded negative results.

It is desired here to repeat acknowledgements, made in Part I, to the Board of Studies, the University of Tasmania, for a research-grant, and to Dr. V. V. Hickman, Ralston Lecturer in Biology, University of Tasmania, for appreciated encouragement and assistance.

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[1] Assuming that LS is the only intrinsic factor for determining duration of survival (it is certainly the dominant, but probably not the sole, factor: see below), we find LS (mm.) minus a constant is approximately proportional to the sixth power of the time (hours).

[2] Specimens were classified in practice as 'light', 'medium light', 'medium dark', 'dark'. Pooling the first two categories as light, and the second two as dark, for total material examined (111 specimens), we get $N_{1—55·5}$ 33·5 light, 22 dark; $N_{55·5—111}$ 12·5 light, 43 dark. Treating these results as a fourfold table for relative survival-duration and relative depth of ground-colour, and calculating χ^2 directly from the formula

$$\chi^2 = \frac{(ad - bc)^2 \ (a + b + c + d)}{(a + b) \ (c + d) \ (a + c) \ (b + d)}$$

where a, b, c, d are the four quantities, we get $\chi^2 = 16·37$, a result which, on entering the table for χ^2 (Fisher, 1932) with $n = 1$ (the system having one degree of freedom), is seen to be clearly opposed to the hypothesis of independence.

Summary

1. Standard and total length are specified for 1415 individuals. The former, which is statistically a logarithmic function of the latter, is morphologically and experimentally the preferable criterion of length-of-fish.

2. Approximately 78% of total (89% of Punchbowl Creek) material is in first year; 8% of total (5% of Punchbowl Creek) material in second year.

3. Minimum, maximum, mean standard length of total material: 185·0, 31·1, 53·81 mm., respectively.

4. Post-larval specimens often exhibit colour-pattern (possibly a primitive family character) on caudal fin; occasionally retain vestiges of yolk-stalk, with associated vascular plexus, in individuals that have migrated 40 miles inland; normally show onset of ground-pigmentation at standard length of about 40 mm.

5. Frequency distribution of standard length has a positive skew.

6. In Punchbowl Creek there occurs an extensive juvenile influx in October, followed by a less important immigration in March, and possibly by an inland movement in July.

7. Emigration of adults takes place about April; fish returning, after spawning, about July.

8. Relation of standard length to Creek-age in Punchbowl Creek: at vernal immigration about 40 mm.; at end of first summer 60 ± 5 mm.; in second year of Creek-age 75 ± 5 mm.; in third, or later season, > 80 mm.

9. Growth-curves of nine dimensions, based on 300 specimens, show relative growth is in general heterogonic, approximating to isogonic: length of caudal peduncle on standard length is an exponential function.

10. Graph of axial growth-potential shows growth-centre in head-pelvic interspace, whence gradient slopes away cephalad and caudad, with a change of sign in region of caudal fin.

11. Fish survive out of water up to 25·5 hours: 46% of specimens examined survived 10 hours, or more.

12. Extra-aqueous viability, as determined by duration of survival, is a direct function of standard length; perhaps, also, of pigmentation-density.

References

Best, E., 1903.—Food Products of Tuhoeland. *Trans. Proc. N.Z. Inst.* XXV. pp. 45-111.

Clarke, F. E., 1899.—Notes on New Zealand Galaxiidae, more especially those of the Western Slopes, with Descriptions of New Species, &c. *Trans. Proc. N.Z. Inst.* XXXI. pp. 78-91. Pl. IV-V.

Fisher, R. A., 1932.—*Statistical Methods for Research Workers.* London.

FLETCHER, J., 1906.—*Proc. Linn. Soc. N.S.W.* XXXI. pp. 430, 497, and 566.

FORD, E., 1930.—Herring Investigations at Plymouth. VIII. The Transition from Larva to Adolescent. *Journ. Mar. Biol. Assn.* 16. p. 723.

———, 1931.—Growth in Length during the Transition from Larva to Adolescent in the Pilchard and Sprat. *Journ. Mar. Biol. Assn.* 17. pp. 977-985.

GÜNTHER, A., 1867.—On a New Form of Mudfish from New Zealand. *Ann. Mag. Nat. Hist.* 3rd Series. 20. 119. pp. 305-309. Pl. VII.

HALL, T. S., 1901.—A Burrowing Fish (*Galaxius* sp.). *Vict. Nat., Melbourne.* XVIII. p. 65.

HECHT, S., 1916.—Form and Growth of Fishes. *Journ. Morph.* 37. p. 379.

HICKLING, C. F., 1930.—A Contribution Towards the Life-history of the Spur-dog. *Journ. Mar. Biol. Assn.* 16. p. 529.

HOLZINGER, K. J., 1928.—*Statistical Methods for Students in Education.* Ginn & Co. U.S.A.

HUTTON, F. W., 1936.—Notes on Some New Zealand Fishes, with Description of a New Species. *Trans. Proc. N.Z. Inst.* XXVIII. 1895 (1896). pp. 314-318.

HUXLEY, J. S., *et al.*, 1927.—Recommendations of the British Association Committee on Biological Measurements. *Rep. Brit. Assn.* 1927. pp. 286-298.

———, 1931.—Notes on Differential Growth. *Amer. Nat.* 65. pp. 298-315.

———, 1932.—*Problems of Relative Growth.* London.

KEYS, A. B., 1928.—The Weight-length Relation in Fishes. *Proc. Nat. Acad. Sci.* 14. pp. 922-925.

LORD, C. E., and SCOTT, H. H., 1924.—*A Synopsis of the Vertebrate Animals of Tasmania.* Hobart.

MCCULLOCH, A. R., 1915.—The Migration of the Jolly-tail or Eel-gudgeon, *Galaxias attenuatus*, from the Sea to Fresh-water. *Aust. Zool.* I. 2. pp. 47-49. One text-fig.

———, 1929.—A Check-list of the Fishes Recorded from Australia. *Mem. Aust. Mus. Sydney.* V. I.

PHILLIPPS, W. J., 1919.—Life History of the Fish, *Galaxias attenuatus*. *Aust. Zool.* I. 7. pp. 211-213.

———, 1926.—New or Rare Fishes of New Zealand. *Trans. Proc. N.Z. Inst.* 56. pp. 529-537. Pl. 87-92.

REGAN, C. T., 1906.—A Revision of the Fishes of the Family Galaxiidae. *Proc. Zool. Soc. London.* 1905. II. pp. 363-384. Pl. X-XIII.

SCAMMON, R. E., and CALKINS, L. A., 1929.—*The Development and Growth of the External Dimensions of the Human Body in the Fetal Period.* Minneapolis.

SCOTT, E. O. G., 1934.—Observations on Some Tasmanian Fishes, with Descriptions of New Species. *Pap. Proc. Roy. Soc. Tasm.* 1933. pp. 31-53. Pl. VI-VIII. Text-figs. 1-2.

———, 1936.—Observations on Fishes of the Family Galaxiidae. Part I. *Pap. Proc. Roy. Soc. Tasm.* 1935. pp. 85-112. Text-figs. 1-4.

SHAW, M., 1928.—A Contribution to the Study of Relative Growth of Parts in *Inachus dorsettensis*. *Brit. Journ. Exper. Biol.* 6. p. 145.

THOMPSON, D. W., 1917.—*Growth and Form.* Cambridge Univ. Press.

PLATE XVIII

FIG. 1.—Map showing distribution of material (mainland of Tasmania only).

FIG. 2.—Percentile curves of standard length. Punchbowl Creek (PC), Non-Punchbowl Creek (NPC), and total Tasmanian (TT) material.

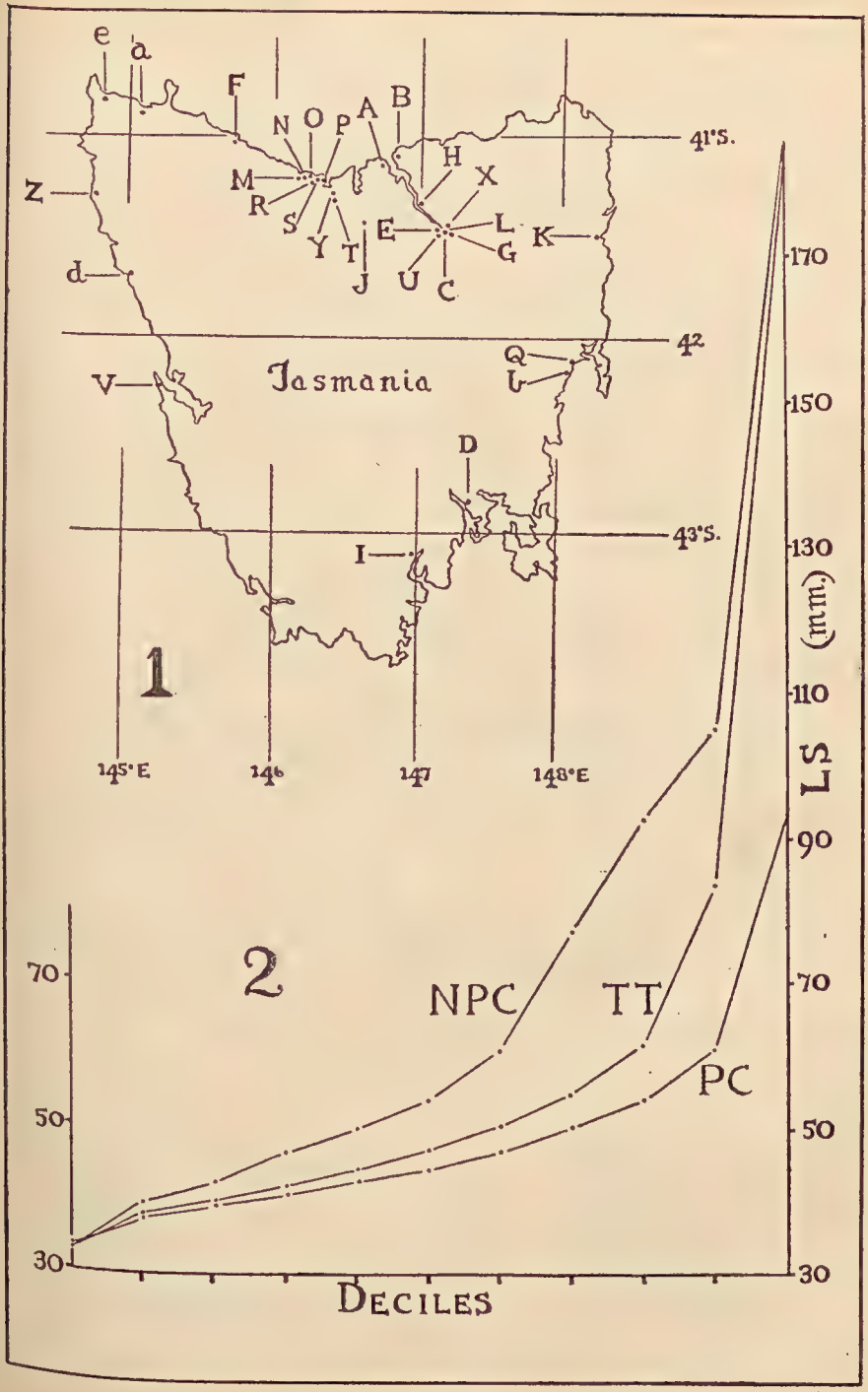
e
a
F
N
O
P
A
B
41°S.
H
X
M
R
S
Y
T
E
L
G
K
Z
d
J
U
C
42
Q
V
Jasmania
D
43°S.
I
1
145°E
146
147
148°E
170
150
130
110
90
70
50
30
(m.m.)
LS
2
70
50
30
NPC
TT
PC
DECILES

PLATE XIX

Frequency distribution of standard length.

FIG. 3.—Punchbowl Creek material. 3-mm. classes.

FIG. 4.—The same. 5-mm. classes.

FIG. 5.—Non-Punchbowl Creek material (solid black rectangles) and total Tasmanian material (combined solid black and stippled rectangles) 6-mm. classes.

FIG. 6.—The same. 10-mm. classes.

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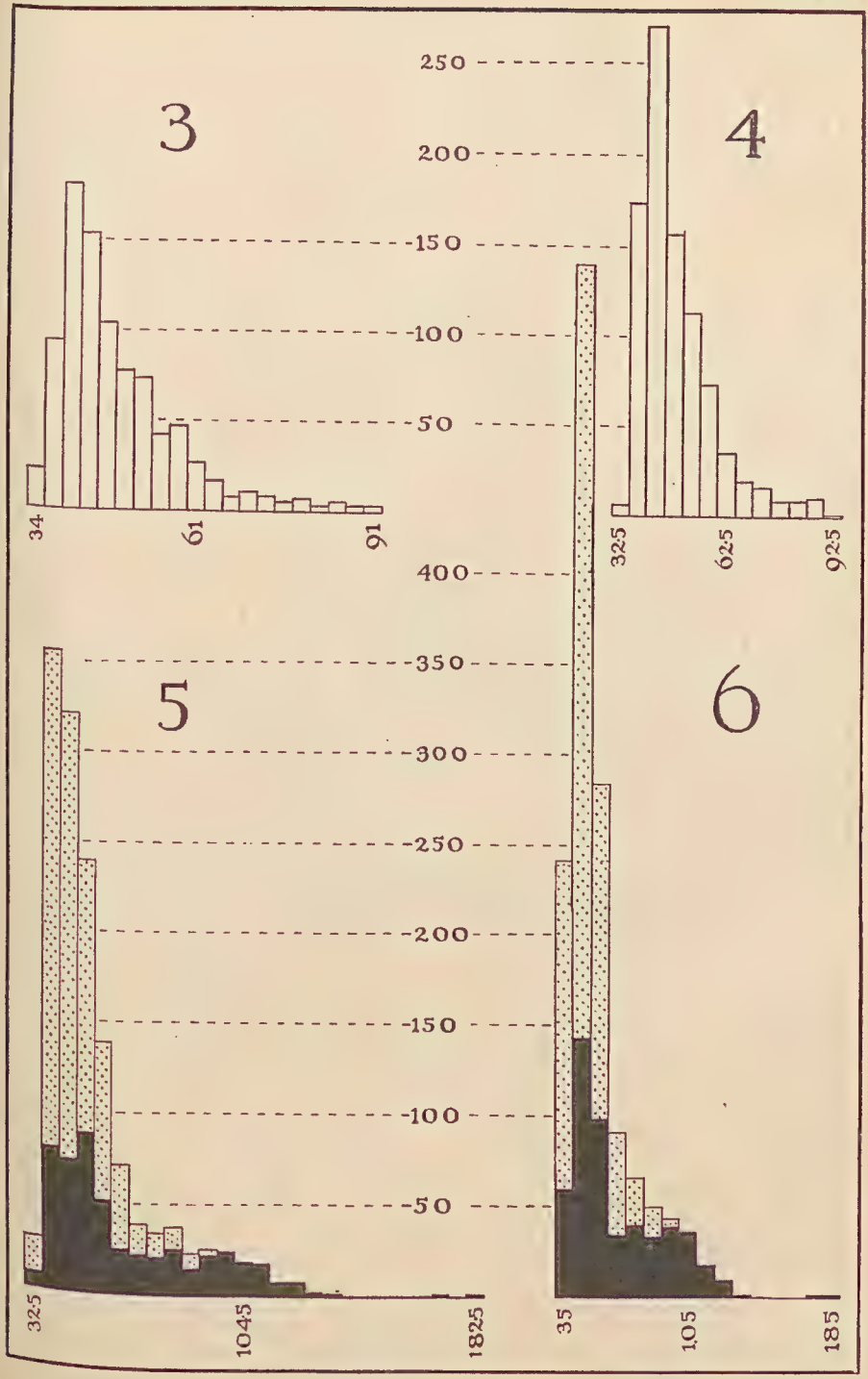
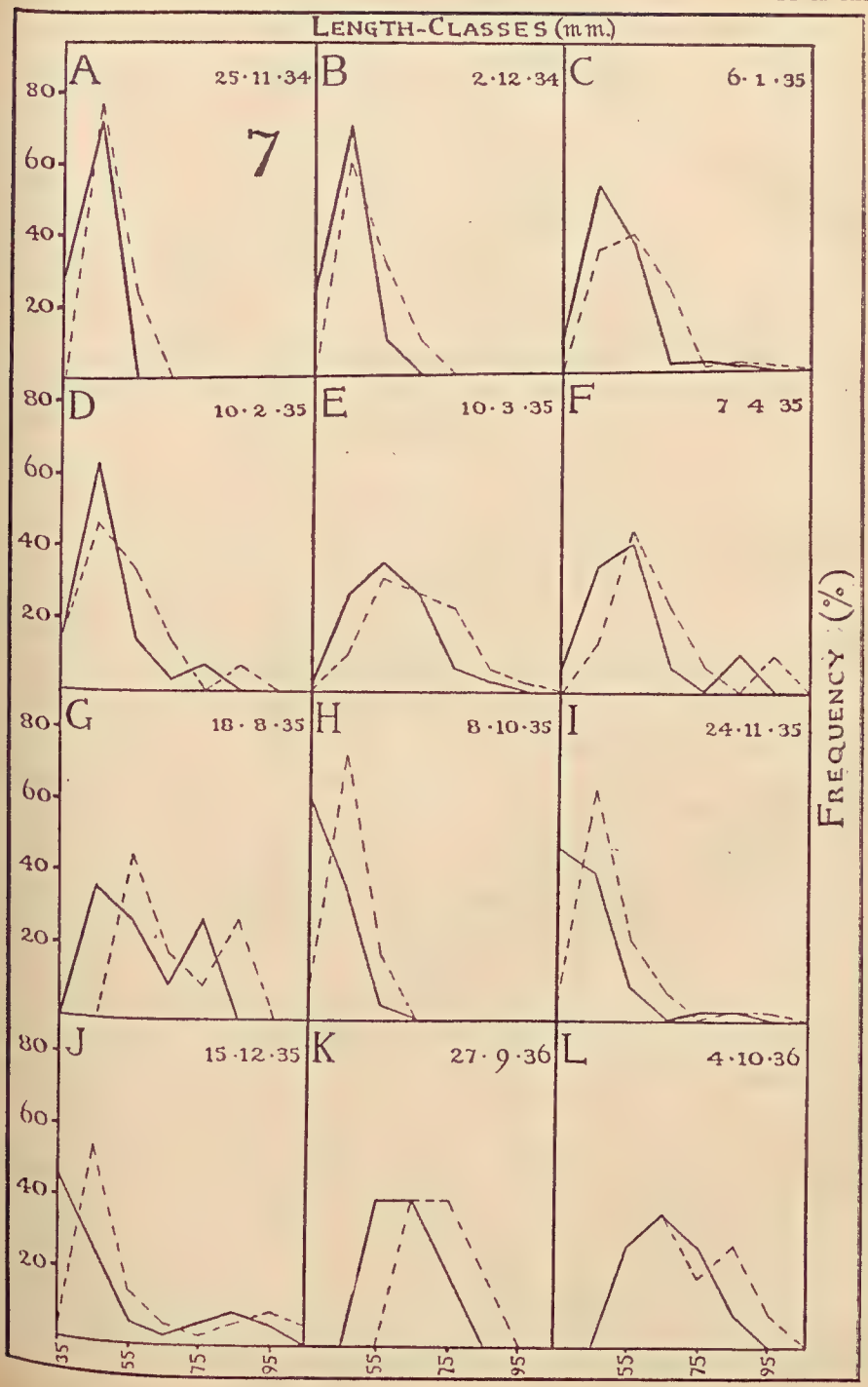
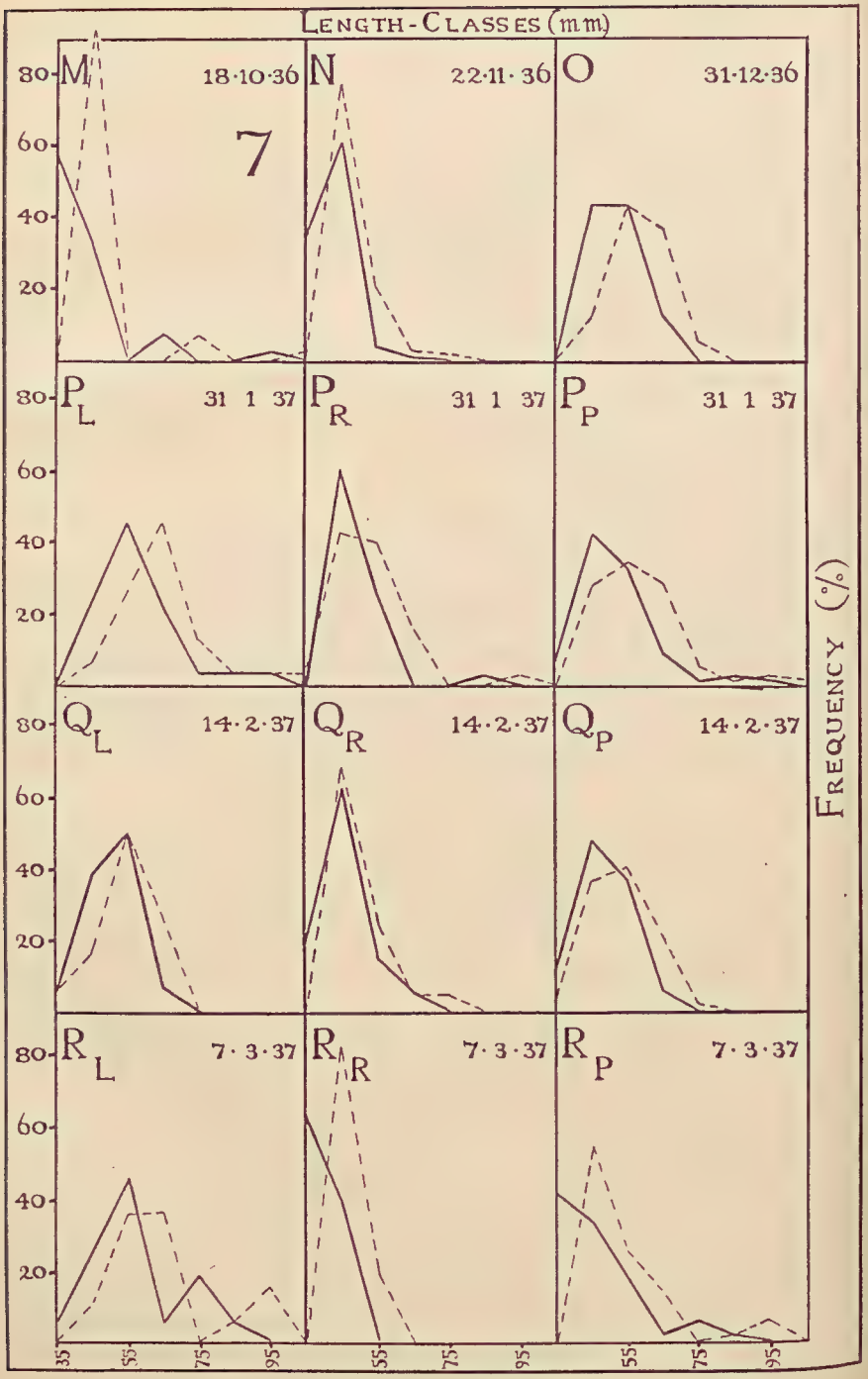

3
4
5
6
250
200
150
100
50
400
350
300
250
200
150
100
50
34
61
91
325
625
925
325
1045
1825
35
105
185

PLATES XX, XXI, XXII

FIG. 7, A-X.—Seasonal frequency polygons of standard length (Punchbowl Creek). Suffixes L, R, P denote, respectively, sample from *Larnoo* section of Creek, sample from Reserve section, and pooled samples from the two sections. Samples without suffix from *Larnoo* section.


Length-Classes (mm.)
A
25·11·34
7
B
2·12·34
C
6·1·35
D
10·2·35
E
10·3·35
F
7 4 35
G
18·8·35
H
8·10·35
I
24·11·35
J
15·12·35
K
27·9·36
L
4·10·36
Frequency (%)
80
60
40
20
35
55
75
95


LENGTH-CLASSES (mm)
M 18·10·36
7
N 22·11·36
O 31·12·36
P L 31 1 37
P R 31 1 37
P P 31 1 37
Q L 14·2·37
Q R 14·2·37
Q P 14·2·37
R L 7·3·37
R R 7·3·37
R P 7·3·37
80
60
40
20
35
55
75
95
FREQUENCY (%)

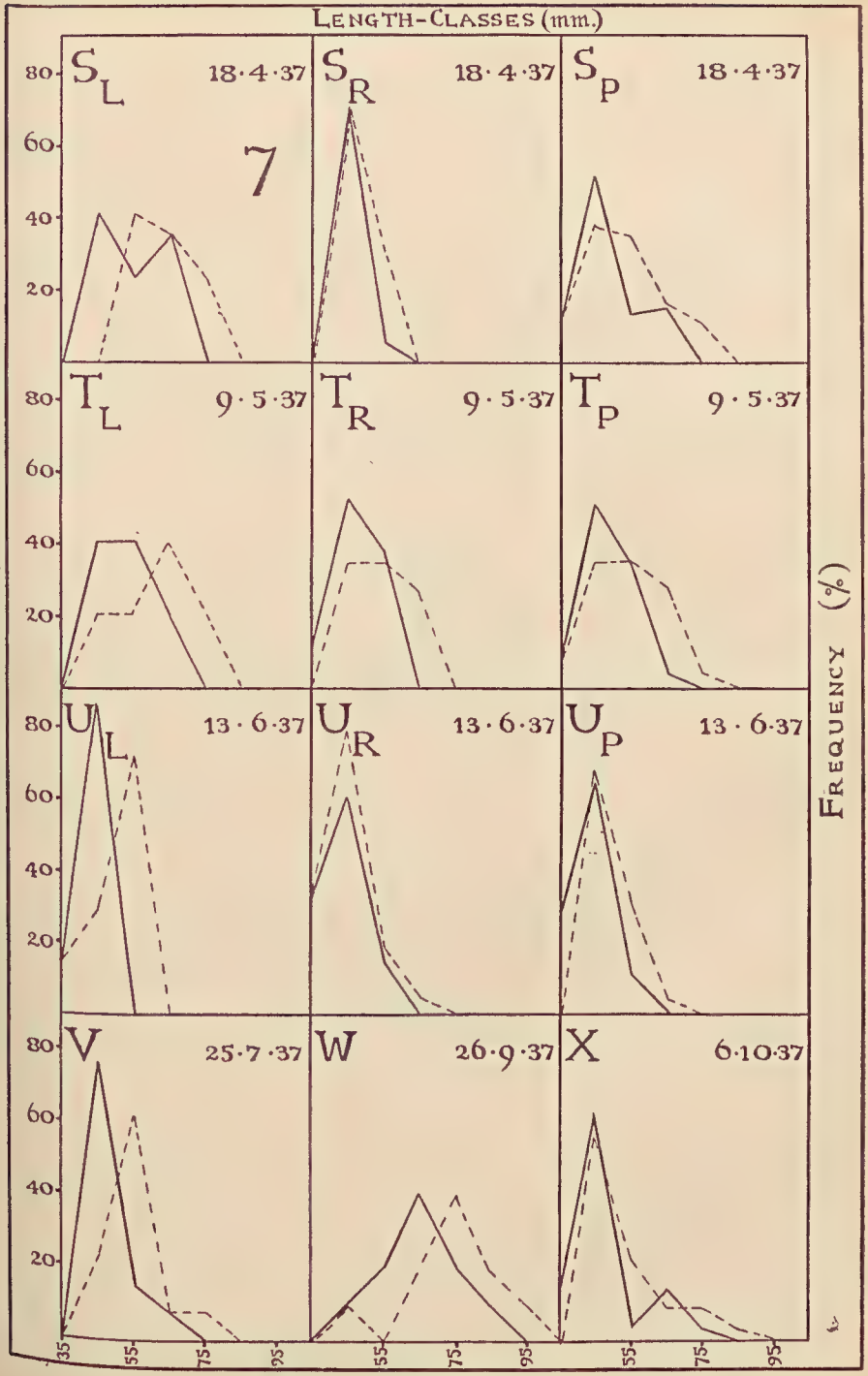

LENGTH-CLASSES (mm.)
S_L 18·4·37
S_R 18·4·37
S_P 18·4·37
7
T_L 9·5·37
T_R 9·5·37
T_P 9·5·37
U_L 13·6·37
U_R 13·6·37
U_P 13·6·37
V 25·7·37
W 26·9·37
X 6·10·37
80
60
40
20
35
55
75
95
FREQUENCY (%)

PLATE XXIII

FIG. 8.—Curves of seasonal variation (Punchbowl Creek) of mean standard length and of standard deviation of standard length.

FIG. 9.—Growth-curves. A, length to origin of dorsal fin; B, length to origin of pelvic fin; C, depth of body (maximum); D, length of caudal peduncle; E, depth of caudal peduncle (minimum); F, length of caudal fin; G, length of head; H, horizontal diameter of eye; I, eye in head; J, depth of caudal peduncle in its length; all plotted against standard length. Direct plotting.

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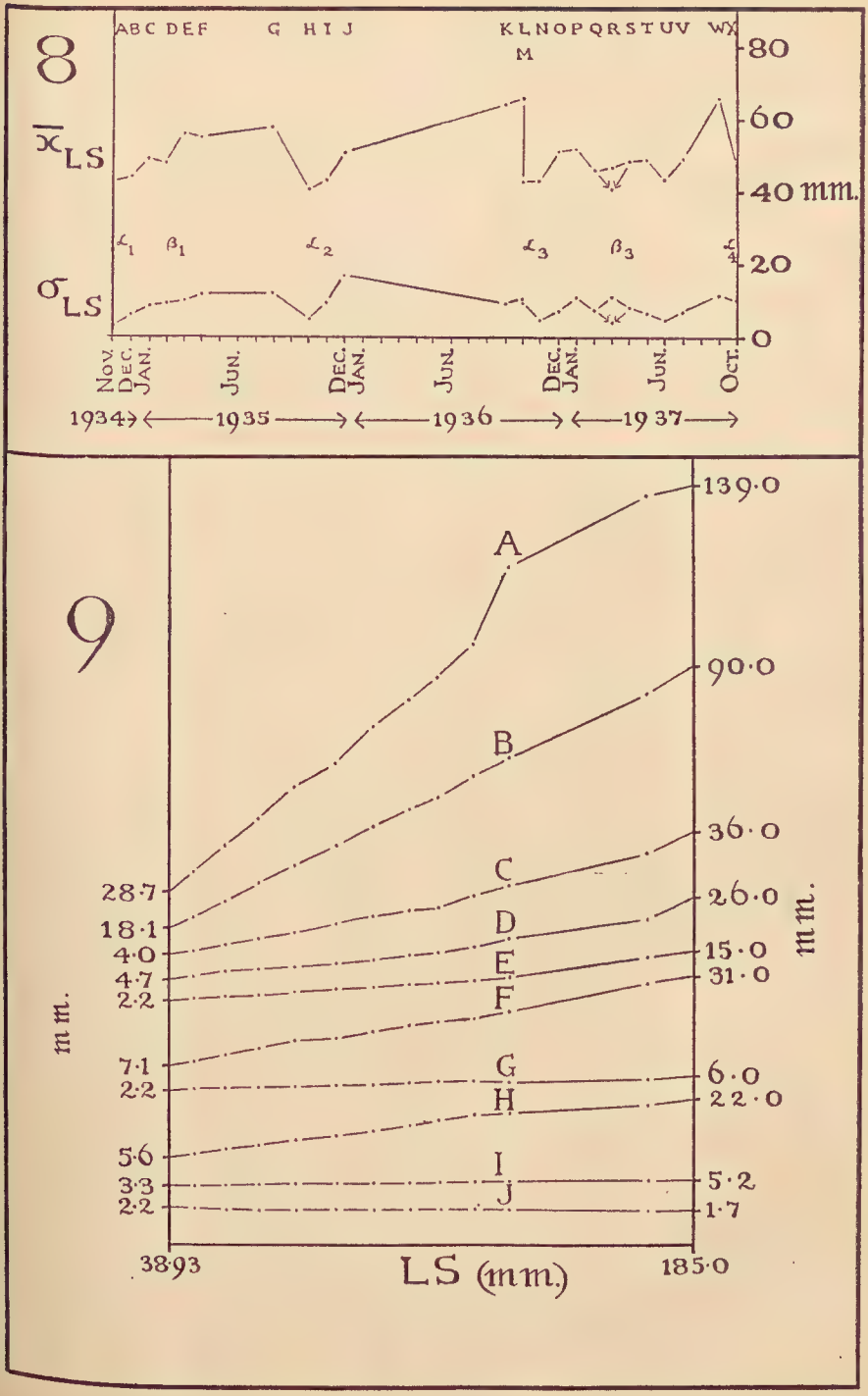
8
A B C D E F G H I J K L M N O P Q R S T U V W X
80
60
40 mm.
20
0
$\bar{x}_{LS}$
σ_{LS}
α_1 β_1 α_2 α_3 β_3 α_4
Nov. Dec. Jan. Jun. Dec. Jan. Jun. Dec. Jan. Jun. Oct.
1934 1935 1936 1937
9
139·0
90·0
36·0
26·0
15·0
31·0
6·0
22·0
5·2
1·7
A
B
C
D
E
F
G
H
I
J
28·7
18·1
4·0
4·7
2·2
7·1
2·2
5·6
3·3
2·2
mm.
mm.
38·93
LS (mm.)
185·0

PLATE XXIV

FIG. 10.—Growth-curves. Lettering as in Fig. 9. Logarithmic plotting.

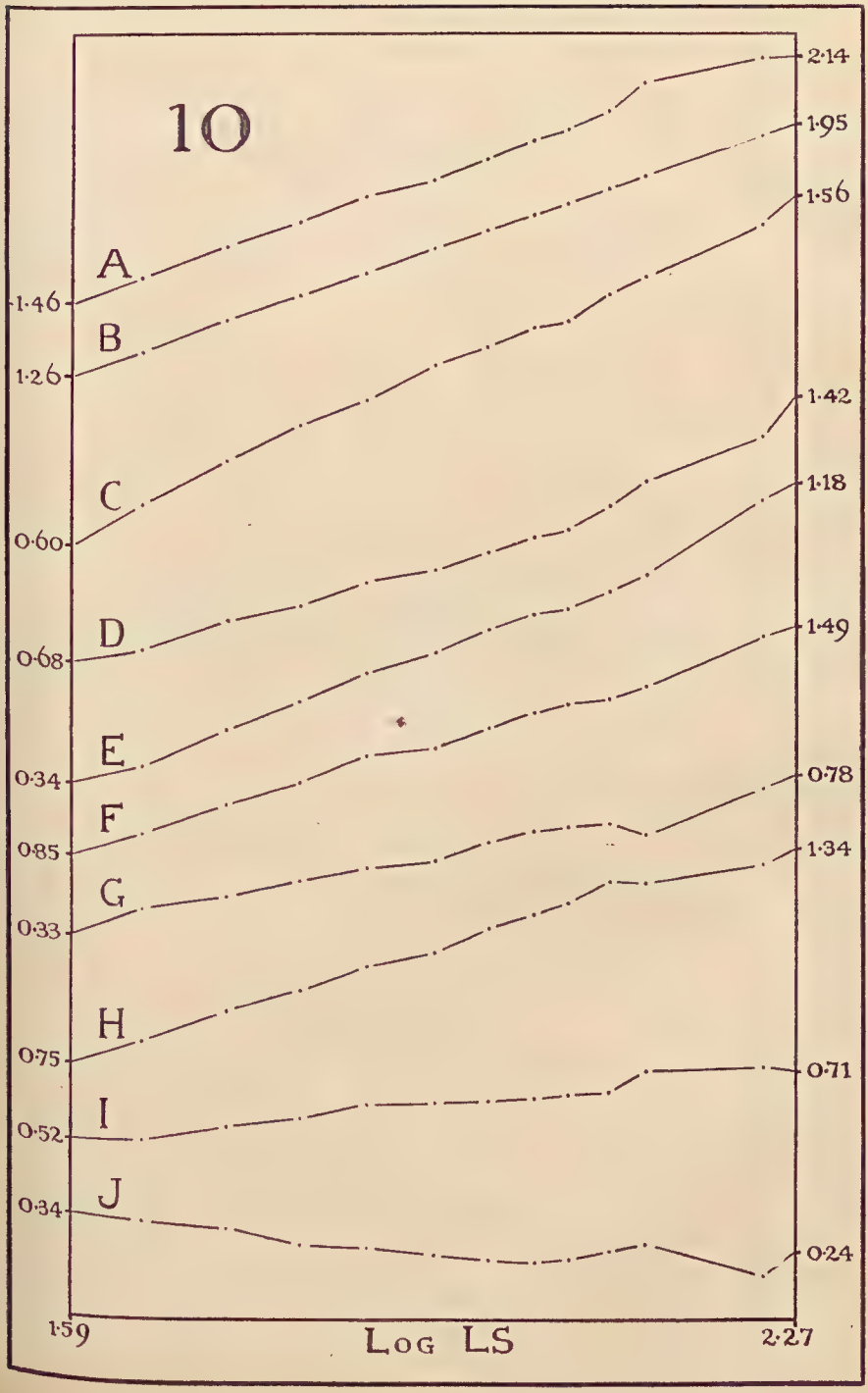
10
A
B
C
D
E
F
G
H
I
J
1·46
1·26
0·60
0·68
0·34
0·85
0·33
0·75
0·52
0·34
2·14
1·95
1·56
1·42
1·18
1·49
0·78
1·34
0·71
0·24
1·59
LOG LS
2·27

PLATE XXV

FIG. 11.—Growth-curves. Eye on head: A, direct plotting; B, logarithmic plotting. Depth of caudal peduncle on length of caudal peduncle: C, direct plotting; D, logarithmic plotting.

FIG. 12.—Axial growth-gradients.

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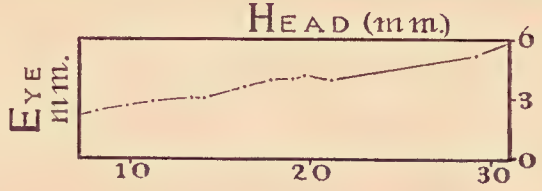
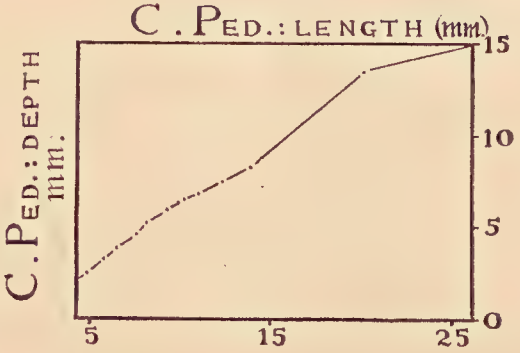
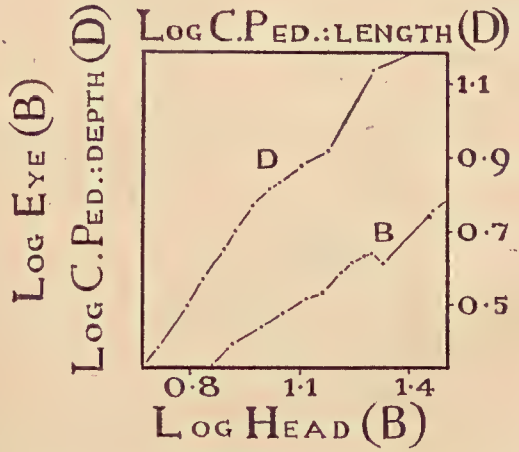
11


Head (mm.)
Eye mm.
6
3
0
10
20
30

A


C. Ped.: length (mm)
C. Ped.: depth mm.
15
10
5
0
5
15
25

C


Log C.Ped.:length (D)
Log Eye (B)
Log C.Ped.:depth (D)
D
B
1·1
0·9
0·7
0·5
0·8
1·1
1·4
Log Head (B)

B, D

12

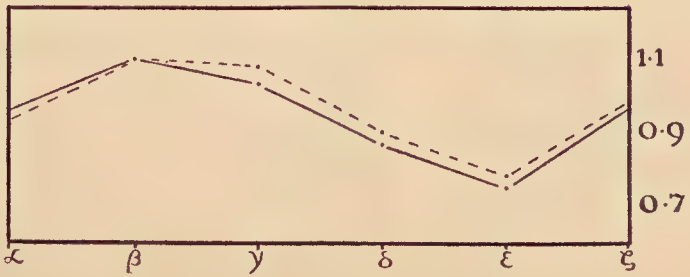
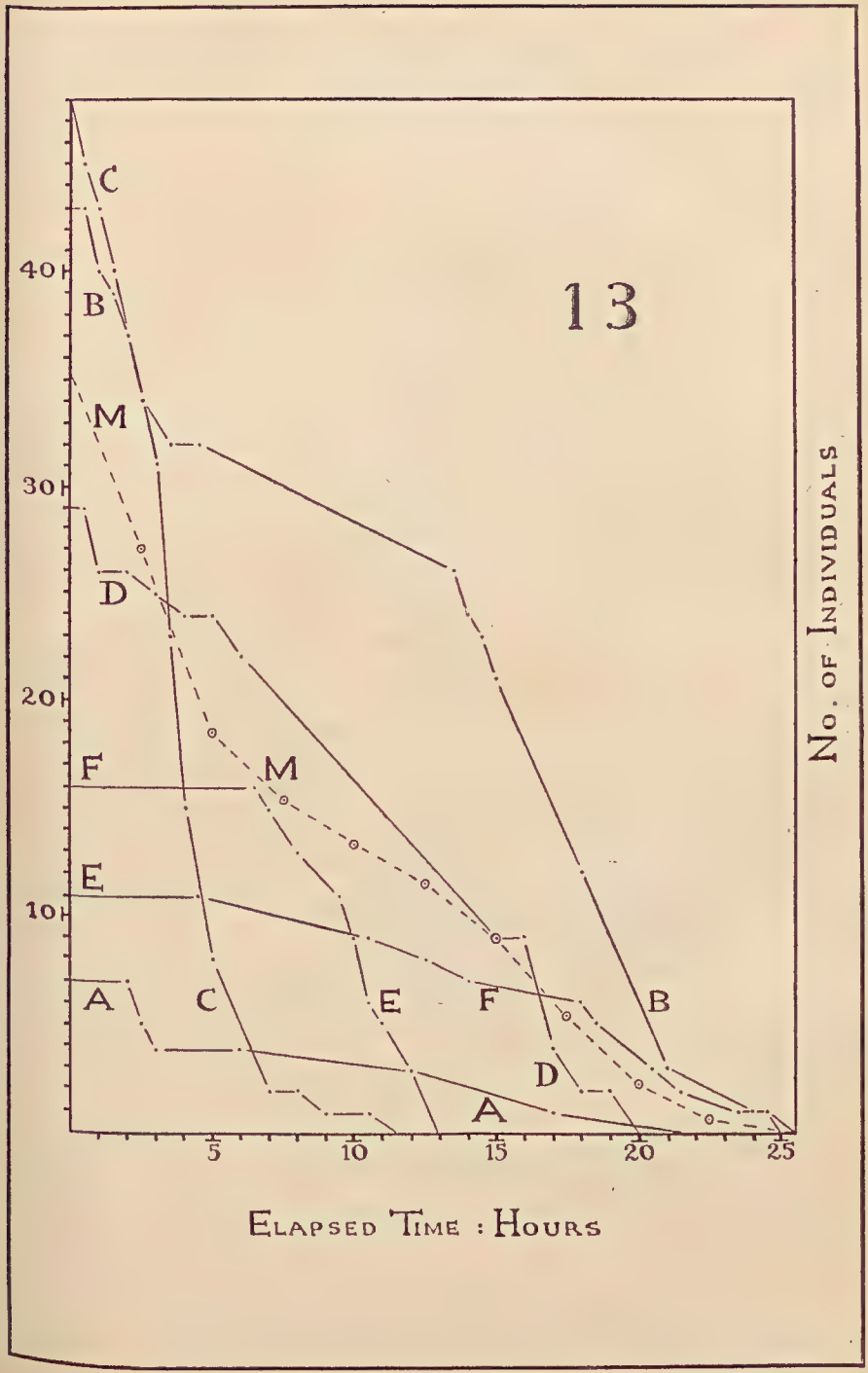

1·1
0·9
0·7
α
β
γ
δ
ε
ζ

PLATE XXVI

FIG. 13.—Duration of extra-aqueous survival. M is weighted average of A-F.

NATIONAL MUSEUM OF VICTORIA


13
C
B
M
D
F
M
E
A
C
E
F
B
D
A
40
30
20
10
5
10
15
20
25
No. of Individuals
Elapsed Time : Hours

NATIONAL MUSEUM OF VICTORIA

PLATE XXVII

FIG. 14.—Standard length plotted against survival-sequence—showing greater viability of larger individuals. M is weighted average of A-F.

A
B
C
D
E
F
M
87·8
60·1
78·3
81·0
61·8
72·8
71·3
45·3
40·3
59·6
48·0
47·5
51·5
48·1
LS (mm.)
SURVIVAL-SEQUENCE
1
5
10
15
20
30
40

14

NATIONAL MUSEUM OF VICTORIA

Notes

Tasmanian Trilobites

Attention is directed to a paper entitled 'Notes on Some Ordovician Faunas of Tasmania', by Teiichi Kobayashi, published in the Japanese 'Journal of Geology and Geography', Volume XIII, Numbers 1 and 2, March, 1936, page 178.

The learned author is a world-famous palaeontologist, and Tasmanian geologists express their appreciation of this interesting contribution to one of our problems.

The conclusion reached by the author from examining material from Caroline Creek and the Florentine Valley is that the trilobite fauna preserved in the sandstones of these localities are of Lower Ordovician age, not Cambrian as previously considered. These sandstones are regarded by Tasmanian geologists to be the lowest members of the extensive series of rocks which lie between the Pre-Cambrian schists and the West Coast conglomerates (base of the Silurian). The effect of this revision of fossil evidence will be to remove *Cambrian* as a term from our successional nomenclature, and confirm the generally accepted view that the very extensive and economically important beds which underlie the West Coast Range Conglomerate Series (e.g., Read-Rosebery Schists, Dundas Slates, Mathinna Slates, Balfour Slates) are of Ordovician age.

Kobayashi describes a new genus under the name *Tasmanocephalus*. This replaces the forms described as *Conocephalites? stephensi* Etheridge. The genus (three species) of *Ptychoparia?* disappear, but the author is not prepared to redescribe these forms from the material available. *Dikelocephalus florentinensis* becomes *Asaphopsis florentiensis* Etheridge, and *Dikelocephalus tasmanicus* Etheridge is regarded as similar to the genus *Tachungshania*, but of uncertain species.

Kobayashi also refers to the occurrence of *Rebeiria* or *Rebeirella* in the Table Cape Conglomerates, and assigns a Silurian age. A note of caution must be sounded here, since these fossils were found in Permian glacial tillite, associated with material some of which has not been found *in situ* in Tasmania.

In an associated paper (*ibid.*, p. 163) the author states interesting views on the distribution of the *Dikelokephalininae*, and shows the relationship between the lower Ordovician fauna of Tasmania and that of Southern Europe, China, and Northern America, suggesting a connecting link in dispersal between Southern Europe and Asia on the one hand, and Northern America on the other, as to which Tasmania can supply vital data.

In view of this recent work, it is suggested that the term *Dikelocephalus Sandstones* should be discontinued, and replaced by the term *Caroline Creek Series*. It is apparent that the interesting fauna of the Caroline Creek and Tim Shea (Florentine) sandstones is worthy of more detailed attention than has hitherto been accorded.

A. N. LEWIS.
8.11.37.

Biological Survey of Tasmania

Early in 1937 a movement was set on foot by a committee of scientists resident in Hobart to undertake a biological survey of the State.

Among the purposes of the projected survey are the determination of the distribution of plants and animals of especial interest within the State; the preparation of lists of the described fauna and flora; ecological surveys of selected districts; and an analysis of the effect of introduced animals and plants on the indigenous fauna and flora. It is expected that the survey will yield information of great interest, and will probably bring to light forms of life previously unknown to science.

The headquarters of the survey are at the Tasmanian Museum, Hobart, and the Director of the Museum, Dr. J. Pearson, is the Chairman of the Executive Committee of the Survey. Funds are being made available by the Australian and New Zealand Association for the Advancement of Science, the Commonwealth Science and Industry Endowment Fund, the State Fauna Board, and by the Forestry Department.

The Royal Society of Tasmania

Annual Report

1937

The annual meeting was held in the Society's Rooms, Tasmanian Museum, Hobart, on the 8th March, 1937.

The following were elected as members of the Council for 1937:—Mr. H. Allport, Mr. S. Angel, Mr. W. H. Clemes, Dr. W. L. Crowther, Mr. J. W. Evans, Mr. W. H. Hudspeth, Dr. A. N. Lewis, Hon. L. M. Shoobridge, Mr. E. E. Unwin.

His Excellency the Governor nominated the following members as Vice-Presidents:—Mr. S. Angel and Dr. W. L. Crowther.

The Council at its first meeting made the following appointments:—

Chairman of the Council: Mr. W. H. Clemes.

Secretary: Dr. Joseph Pearson.

Hon. Treasurer: Mr. S. Angel.

Standing Committee: Dr. Lewis, Mr. Unwin, and the Secretary.

Representatives of the Society on the Board of Trustees of the Tasmanian Museum and Art Gallery and Botanical Gardens:—Mr. W. H. Clemes, Mr. S. Angel, Mr. W. H. Hudspeth, Dr. A. N. Lewis, Hon. L. M. Shoobridge, Mr. E. E. Unwin.

Ten meetings have been held during the year, and in addition to the lectures delivered scientific papers of considerable value and interest were submitted for publication.

(See abstract of meetings for abstracts of lectures, papers, &c.)

The Society's library continues to be used extensively by members and many others desiring historical and scientific information. During the year a number of new volumes have been added to the various sections. In December, 1936, the number of books totalled 18,733, and in December, 1937, 18,984, showing that 251 volumes have been added.

A very valuable gift to the library has been made by Mrs. L. Rodway, who has donated the whole of the botanical books belonging to the late Mr. Rodway. It is proposed to have these suitably labelled as the Rodway Memorial Library, and they should prove of great value to students of botany.

The membership for the year, compared with that of 1936, is as follows:—

	1936.	1937.
Honorary members	3	2
Corresponding members	3	3
Life members	7	7
Ordinary members	233	241
	246	253

During the year 16 names were removed from the membership owing to deaths, resignations, &c., and 23 new names were added.

The Council regrets to have to record that the following members have died during the year:—

Mrs. C. S. Agnew.
Dr. R. J. Tillyard.
Dr. R. G. Scott.
Lt.-Colonel G. Harrap.
Mr. Hector Ross.

During the year the rules of the Society have been revised and brought up to date, and it is hoped to print these revised rules during 1938.

A request was received for the publication of a classified index to the Papers and Proceedings published subsequent to the last published index, and the Council arranged for this work to be undertaken by several members of the Society. When the index is completed it will supply a long-felt want.

The Government has assisted again with the printing of the Papers and Proceedings, and this concession is greatly appreciated by the Council.

Abstract of Proceedings

1937

24TH FEBRUARY, 1937

A special meeting of the Royal Society of Tasmania was held on this date to celebrate the centenary of the arrival of Sir John and Lady Franklin in Tasmania.

His Excellency the Governor, Sir Ernest Clark, K.C.B., C.B.E., President of the Society, presided, and His Excellency the Governor-General, Lord Gowrie, was also present. The President opened the meeting by discussing the character of Sir John Franklin and the significance of his work in Tasmania. The Governor-General also spoke.

These speeches were followed by a paper by Mr. J. Reynolds on Sir John Franklin. Mr. W. Hudspeth then gave a paper on Lady Franklin, in which he drew upon personal letters which she wrote while in Tasmania. At the end of his paper Mr. Hudspeth showed a series of lantern slides dealing with the Franklin period.

The meeting then adjourned to the Museum, where a number of Franklin relics were examined which had been displayed temporarily in the Ethnographical Gallery.

8TH MARCH, 1937

Annual Meeting

The annual meeting was held in the Society's Rooms, Tasmanian Museum. The Vice-President, Mr. F. E. Ward, presided in the absence of the President, His Excellency the Governor.

The following were elected as members of the Council for 1938:—Mr. H. Allport, Mr. S. Angel, Mr. W. H. Clemes, Dr. W. L. Crowther, Mr. J. W. Evans, Mr. W. H. Hudspeth, Dr. A. N. Lewis, Hon. L. M. Shoobridge, Mr. E. E. Unwin.

Mr. Walter E. Taylor was appointed Hon. Auditor.

The following were elected members of the Society:—Professor F. R. E. Mauldon, Major W. T. Conder, Mr. T. V. Williams.

Dr. Joseph Pearson delivered an illustrated lecture on 'The Furniture of the 17th and 18th Centuries', of which the following is an abseract:—

> Dr. Pearson showed pictures of the different styles of chairs, cupboards, and tables, as they followed one on the other, treating the subject somewhat from the point of view of the student of comparative anatomy. He said the furniture of the 17th and 18th centuries was not only European, but

also colonial. The whole development hinged on the evolution of the chair. Until the 16th century the chair was hardly known in the home, being used only by kings and bishops and others in authority. Most men and women sat on forms or chests. Chairs were connected with State occasions, and particularly with churches. The early church chairs were stalls, with fixed seats, with legs forming part of a box, and often with a canopy. In the following type the arms disappeared. The strength and massiveness were gone, and at the beginning of the 17th century such chairs might be found in kitchen or cottage parlour. They were uncomfortable, but useful. The next type was plain, with no ornamentation except in the legs and the front stretcher. The back was upholstered. The chair was common throughout Europe. Another type of the same period was more elaborate, and was known as the Yorkshire or Derbyshire chair. A picture, taken in Java, showed a chair that was late Renaissance in style. It was still very uncomfortable. The next type was a great advance, having spiral turning in the legs, in the front and back stretchers, and in parts of the back. It first appeared in England about 1660. It was taken to the East by the Portuguese. The style originated in Europe, and was well known in the Gothic churches of the 13th and 14th centuries.

Dr. Pearson traced the rise of the spiral column and of the Flemish scroll, the development of cane seats and back, and the application of tapestry. The influence of the Huguenot craftsmen after the revocation of the edict of Nantes was described as affecting furniture design not only in England and Holland, but also in South Africa.

The development of the splat, or central panel, in the back of the chair, was shown gradually becoming smaller. The Spanish scroll was seen to grow by easy stages into the cabriole legs characteristic of the Georgian chair. Dr. Pearson described the work of Chippendale, Hepplewhite, and Sheridan, and said the 18th century ended in a very severe but pleasing tone. Cupboards, tables, gravestones, and so forth, were illustrated, and the influence of rococo decoration, with its lack of symmetry, was described. The Dutch burgomaster chair (about 1650), with its semi-circular back, was shown in several beautiful slides.

12TH APRIL, 1937

A meeting was held in the Society's Rooms on this date. In the absence of the President, His Excellency the Governor, the chair was taken by Mr. Henry Allport.

The following were elected members of the Society:—Miss E. I. Knight, Miss L. E. Knight, Miss N. Davern, Mr. W. J. T. Stops.

Dr. G. H. Hogg gave an interesting lecture entitled 'D'Entrecasteaux: An Account of His Life, His Expedition, and His Officers'. (See this volume, p. 53.)

10TH MAY, 1937

A meeting was held in the Society's Rooms on this date, Dr. W. L. Crowther presiding in the absence of the President, His Excellency the Governor.

The following were elected members:—Mr. H. C. Lewis, Dr. C. R. Brothers, Mr. E. W. Little.

Mr. J. M. Counsel delivered an illustrated lecture entitled 'The Italian Foundations of Painting from Michelangelo to Giotto', of which the following is an abstract:—

Mr. Counsel said there was no acute aspect of human nature that was not illustrated in the story of the painters. He illustrated the work of Michelangelo, and said it showed the obstinacy with which the artist persisted in his claim that he was not a great painter but a sculptor. He employed the sculptor's methods, and this was evident in his drawing of the human figure. The lecturer referred to a collection of frescoes painted by Michelangelo, and pointed out that there was no ornament or background, but through all the examples of his work there was noticeable a rhythm, which was the life and soul of all great painting and sculpture.

Mr. Counsel showed a painting of the Annunciation by Leonardo, and said it was one of the most notable examples of the science with which he built up his art. The whole work was a most scientifically thought-out production. Raphael was unique in that his work summed up all the progress that had gone before. This artist also had his moments of strong rhythm. Illustrations were shown of the work of Italian painters and their influence down to Giotto.

14TH JUNE, 1937

A meeting was held in the Society's Rooms. In the absence of the President, His Excellency the Governor, Mr. S. Angel presided.

The following members were elected:—Mr. C. E. Bisdee, Mr. L. A. Burt, Mr. D. A. Davie.

Mr. A. Lismer, A.R.C.A., Educational Supervisor of the Toronto Art Gallery, Canada, delivered an illustrated lecture entitled 'Art in a Changing World', of which the following is an abstract:—

Mr. Lismer said art and life had become separated. Persons lived in a brittle, sophisticated world of commercialized entertainment and industrialized movies and radio. They passed through streets that were often ugly and depressing, and analysed and speculated on the nature of the physical universe, but failed to keep alive within them the wonder and awe at their actual passage through life. It was essential to human existence that they should at least try to summarize their responsibility, and face the evidence that in life to-day art was missing grievously.

Art is not something outside ourselves, a perfection, a completion of life. It is within, a developing force, a vitality, and a rhythm. It is consciousness of environment, and understanding of the significance of the beauty and character of things in nature and in the human mind. We cannot look round in our cities to-day and see without pain all the ugliness that man has created to express this possessiveness—the ugly rows of houses, the mean little shops, the brutally stark factories, and the sordid railway sidings. Compare these with a little Gothic town or an English village, and feel the difference and the price we have paid when science and industry have created standards of living, and not art. To bring the responsibility down to our own problems when so many have failed in the eternal combat between materialism and idealism is a gigantic task, but it will have to be tackled again and again in a thousand ways. Through art we can achieve an educational revival that would be an antidote to banality and commonplace living. There is one supreme art possible through the non-creative individual, and that is the art of appreciation.

Mr. Lismer said he made no apology for introducing idealism into education. Perhaps that was what was needed more than anything else. He did not think that reading, writing, and arithmetic were fundamentals of education at all. None of them was good unless illustrated by a creative attitude. They were held down by what parents thought about education, and by what industrialists thought about it. The most important things were the understanding of leisure and the use of it. It was in leisure time that all the good or all the mischief in life was done.

If the child were given art in his most rhythmic and vital period of growth, and was fed with the means to keep his senses keen, it did not matter whether he became an artist or not. But it did matter whether he adopted too early a merely predaceous attitude to his fellow men, or whether he saw life creatively, and with understanding and recognition of the various stepping-stones to higher places. He advocated the encouragement of the understanding of contemporary art, which included all endeavours to create civic beauty and to preserve all natural playgrounds and beauty spots.

The lecturer showed a number of lantern slides illustrating art in various forms. He pointed out from the pictures that their value was not represented merely in the scenes portrayed, but in the character, either of the persons or places, they revealed. In a number of pictures by children, he stressed the creative imagination and dynamic force which they displayed. He urged that children should be allowed to cultivate their originality, rather than to receive a stereotyped education.

12TH JULY, 1937

A meeting was held in the Society's Rooms, the President, His Excellency the Governor, presiding.

Miss M. E. Griffiths was elected a member of the Society.

Mr. L. Cerutty delivered a lecture entitled 'Science and Utopia', of which the following is an abstract:—

Justice and harmony were features of the Ideal State described by Plato; More described perfect concord as characteristic of Utopia; but these and other inventors of the perfect society have failed to suggest a means of attaining such perfection. It is characteristic of most of us that we prefer to concentrate on the problems of the moment and leave the designing of Utopias to visionaries; indeed, it becomes more difficult every day to guess the probable trend of our civilization, so potent are the effects of science upon it.

So great is the power of applied science that some have begun to distrust it. The brilliant satire of the scientific millenium described by Aldous Huxley, and the increasing accusation that the scientist is morally responsible for the horrors of modern warfare, are indications of such distrust. One can understand the plea for a ten years' holiday in scientific investigation.

Nevertheless science has something definite to offer society in addition to material gifts. Modern Utopias inevitably are based upon such material progress, but we should do better to base our plans less upon the results of scientific investigation—which may be readily applied in a foolish fashion—and more upon the methods of science.

The search for truth is essential. Professor Hogben has described our age as retreating from reason, and one has only to consider the amazing theories which are invented to support political systems abroad, and the still more amazing claims and suggestions of party politicians at home, to agree with him. Compare this passion for falsehood with the passion

for truth which has marked, for instance, inquiry into the structure of matter by the physicist and the chemist; the difference in the attitude to truth and to reason is startling.

Then, again, the faith of the scientist in ultimate harmony and order is essential to progress. His faith in natural law as correlating the confused mass of facts carries him in advance of his observations, and belief in the truth of his speculations has at times carried him on in spite of neglect by his contemporaries, as witnessed by the lives of Kepler and von Mayer.

A respect for truth and faith in the possibility of ultimate harmony will help in the attainment of the Utopian 'perfect concord'.

At the conclusion of the general meeting members adjourned to the Art Gallery for the unveiling of a portrait of the late Leonard Rodway, C.M.G. Dr. Crowther, in a short speech, asked the Governor to unveil the portrait, and His Excellency did so, after having spoken on certain aspects of the life of the late Mr. Rodway. Members of the family of the late Mr. Rodway were present at the function, as well as members of the Royal Society and subscribers to the Rodway Memorial Fund.

9TH AUGUST, 1937

A meeting was held in the Society's Rooms, Dr. W. L. Crowther presiding in the absence of His Excellency the Governor.

The following members were elected:—Mrs. Walter Gellibrand, Mrs. W. H. Williams, Dr. H. D. Gordon, Mr. A. J. Halls, Mr. W. E. Mitchell, Dr. J. S. Reid, Hon. Alan Wardlaw, M.L.C.

Illustrated papers on Forestry Problems were given by Mr. S. W. Steane, Mr. C. G. Stephens, and Mr. J. W. Evans:

Mr. Steane took as his subject 'Forest Problems'. He said the principal functions of State forestry are to produce continuously certain defined minimum quantities of timber and other forest products, and to provide continuously certain desirable forest effects.

The problem of the protection of forests depends for its satisfactory solution on the support of public opinion, since practically all forest fires in Tasmania are started by human agency, and fires, although the most important menace to forests, are not the only ones. After fire-lighters, splitters, who test trees to see whether they will split easily, are the worst offenders. They damage innumerable trees, and in many cases the wounds give entrance to insect borers, which in the total cause a very serious volume of damage. In conclusion, reference was made to the botanical problem offered by Tasmania's eucalyptus trees.

Mr. C. G. Stephens, speaking of 'The Tree and the Soil', said his talk was divided into two portions, namely, the effect of the soil on the tree, and the effect of the tree on the soil and its products. The former was illustrated by reference to the growth vigour of *Pinus radiata* over a wide series of soils, varying from very acid humus podsols to slightly alkaline soils over limestone. It was also shown how different soil types, by producing trees of different configuration, are responsible for varying grades of timber. The suitability of certain species of trees for different soil conditions was illustrated.

The latter half of the talk was devoted to quoting a miscellaneous series of facts illustrating the various points. Mention was made of the effect of trees on soil type, the value of trees as shelter-belts, particularly on the North-West Coast and in the Midlands of Tasmania, and the response of crops to shelter, where provided.

Mr. Evans spoke on 'Forest Entomology'. He said that insects comprise the greater part of the animal inhabitants of forests, and it is probable that their beneficial activities more than offset their destructive ones. Beneficial insects comprise those that assist in the disintegration of dead timber, scavengers, and parasites and predators of noxious insects. Amongst the harmless forest insects occur certain representatives of primitive groups that are of great scientific interest.

A number of forest insect pests were described and their habits briefly referred to, and in conclusion it was mentioned that no forest entomological research had ever been undertaken in Tasmania, although several important problems are in need of investigation.

13TH SEPTEMBER, 1937

A meeting was held in the Society's Rooms, Mr. S. Angel presiding in the absence of His Excellency the Governor.

The following members were elected:—Miss O. M. Pink, Mr. R. F. Cane.

The following motion was proposed by Mr. N. Oldham, seconded by Mr. A. L. Butler, and carried unanimously:—

'That the Council of this Royal Society, in conjunction with the Trustees of the Tasmanian Museum and Art Gallery, take into consideration the placing in this building of some permanent suitable tribute to the memory of the late J. W. Beattie'.

Professor F. R. E. Mauldon gave a lecture entitled 'Economic Science and the Community', of which the following is an abstract:—

Professor Mauldon traced the concept of political economy from the time of Aristotle, when it was used narrowly to describe the financial aspect of the art of government, to the late 19th century, when it had come to have reference to a highly theoretical system about the nature of those economic forces to which economic policy must accommodate itself.

Economic science is the core of a group of intellectual and practical disciplines now called economics. The service which the science can give the community will be chiefly in providing tested criteria by which probable results of practical proposals may be gauged in advance. The economist makes no pretence to be a seer or a prophet, but there must always be an element of prophetic reasoning in his work, just as there must be in the reasoning of the physical scientists. Economic science can and does bring the spirit of science to the consideration of practical problems in every department of economic life, thus encouraging rational, i.e., ordered, thinking. It is available to show the most economical relations between means and ends, between path and goal. Some things economic science cannot do. It is often expected of the economist that he should first assume responsibility for myriad individual decisions which on aggregate forces produce the disturbing fluctuations of the economic system, and then, by some means or other, acquire power to still the waves of the storm when it breaks. The economist can do neither of these two things.

As a citizen, the economist is expected to give certain specialised services as a teacher, an adviser, and as a collaborator. These are rightful roles for him to occupy, provided he is aware of the limitations and dangers attached to them. He should never neglect the consideration of the 'long period', whatever the expediencies of the 'short period' to which those he may be advising or helping may be driven. He must avoid the habit of political-mindedness. He must expect to forego the pleasures of vigorous partisanship, and be careful lest reforming zeal destroy his capacity for dispassionate analysis. He must expect to tread a straight and difficult way, beset by temptations and misunderstandings. Even though his stand for tolerance, fairness, and dispassionate search for truth is apt to be at a heavy discount in the popular estimation, it is the essential basis of the contribution which economic science gives to the community.

11TH OCTOBER, 1937

A meeting was held in the Society's Rooms, the President, His Excellency the Governor, presiding.

The following new members were elected:—Mr. B. J. F. Ralph, Mr. T. J. Hallam.

As the rules of the Society were out of date the Council had revised them. The revised rules were submitted to this meeting and, subject to certain amendments, were passed.

Mr. W. E. Masters gave an interesting illustrated lecture entitled 'The Semaphore Telegraphic System of Early Van Diemen's Land', of which the following is an abstract:—

Prior to the advent of the electric telegraph and telephone in this island all messages relating to shipping, as well as Government, military, and civil messages, were from the middle twenties of last century transmitted by means of moving-arm semaphores.

The first semaphore used was an adaptation of a two-armed type which had been introduced into England a few years before.

Although the first moving-arm semaphore was introduced into the Royal Navy about 1816, it was not until some years later that the two-arm type, used chiefly for signalling the movements of shipping, came into use on the coasts of England. In the middle twenties this type of semaphore was introduced into Van Diemen's Land—displacing an earlier system of flags and balls used to signal arrivals and departure of shipping. The code then in use appears in the 'Hobart Town Almanac' (James Ross), 1829. The first chain of stations was Mulgrave Battery, Mt. Nelson, Mt. Louis (near Pearson's Point), and Mt. Royal (near Three-Hut Point). These semaphores had two arms, one above the other. Each arm revolved, and had three positions on each side of the staff. Certain positions of either or both arms denoted certain numbers, but there was no orderly rotation of the arms as in the later types, and the code was limited and hard to memorize. The apparatus required to cause the arms to revolve was cumbersome, and apt to become easily damaged.

In the thirties an improved type came into use. It had three single revolving arms, the top arm representing units, the middle one tens, and the lower one hundreds. Each arm could make positions indicating 1, 2, and 3 on one side of the staff, and 4, 5, and 6 on the other side, but there was no provision for making 7, 8, and 9. The signals were all done by

numbers, and at no time during the semaphore telegraph period were the positions of the arms used to denote letters, as in the Army and Navy to-day.

The last and greatly improved type was introduced in the thirties, and under Captain Charles O'Hara Booth, of the 21st Fusiliers, the fifth, and in many respects the ablest, of the commandants at Port Arthur, this

type of semaphore became a most useful and efficient telegraph. The semaphore now had three pairs of double arms; each arm moved on one side of the staff only, and the cumbersome revolving apparatus was discarded. The top pair represented units, the middle pair tens, and the lower pair hundreds, as before, but provision was now made to signal 7, 8, and 9. No cypher was necessary, as when, e.g., the arms of the units pair had counted up to 9, and it became necessary to count 10—the arm on the middle, or 'tens', pair was raised to make '1', signifying 10, and so on. Captain Booth was an enthusiast, constantly visiting the different stations, occasionally moving them to more suitable sites, constantly improving the gear, and keeping his signallers up to a high state of proficiency.

An elaborate code was compiled; each letter of the alphabet had its own number, and words beginning with the different letters all had numbers. Long sentences including questions, answers, orders, &c., were grouped under headings arranged for quick reference. The method of working the arms and conducting the signalling were all clearly set out in the code-books. Three flags were used, viz., the Blue Peter, the 'Preparative' or 'Get ready' flag displayed when a message was about to be sent: the tricolour, to denote that the number shown on the arms was a number merely, and not a number in the code; and the 'chequered' or 'millesimal' pennant, to denote 'thousands'. On the arms alone it was possible to count up to 999. By making a number on the arms with the pennant at half yard-arm, the number was read as 'thousands'. If additional figures were to be added, a further number was made on the arms with the pennant run up to the yard-arm. So efficient did the signallers become that it was possible on a clear day to send a message from Port Arthur to Hobart Town and get a reply within fifteen minutes, passing through five stations each way. High winds, smoke, or fog hindered the signallers, and no provision was made for signalling at night by lamps, although at an early stage this improvement was suggested by Captain Booth.

The map shows the principal stations in the south of the island. The semaphores were set in some cases on the tops of high trees on hills or prominent bluffs, and temporary semaphores were used by the military posts at different places in the island, these, however, forming no part of the regular circuits. On the Tamar fine work was done until 1869 by stations on Windmill Hill, Mt. Direction, Mt. George, and Low Head. These were done away with when the cable was laid from the Victorian coast to Low Head. The last message made on a semaphore was that shown on the Mt. Nelson station, just prior to the dismantling of the mechanism ofter the installation of the telephone, and the word signalled was 'forgotten'.

The old signal station at Princes' Park, Castray Esplanade, Hobart, is the last remaining building in the former chain of stations in the South. The semaphore at Battery Point was erected, in the first place, at the top of the hill, approximately in the position of the present signal staff, but was later removed to what had been the guard-house at the Mulgrave Battery, and at this old building, still standing, all telegrams were sent and received for many years until the electric telegraph rendered it obsolete. The Hobart Museum has in its possession a fine model, made by the late Mr. Thomas Bennison, showing this station in its working days. Portion of the standards for the dead-eyes of the rigging still remain in front of the old building, showing that the semaphore staff stood in the same position as the flagstaff of to-day. The lecture was illustrated by a working model and lantern slides.

8TH NOVEMBER, 1937

A meeting was held in the Society's Rooms, the President, His Excellency the Governor, presiding.

Mr. Cecil W. Baldwin was elected a member of the Society, and Mr. Francis H. Foster was nominated for membership.

His Excellency explained that a meeting had been held on Friday, 29th October, 1937, at 5 p.m., when it had been decided to open a fund, to be controlled by the Council of the Royal Society, with the object of purchasing modern books on Australian history, geography, and anthropology, as a memorial to the late J. W. Beattie.

The following papers, submitted for the 1937 Papers and Proceedings, were tabled, and referred to the Standing Committee:—

'Some Biometric Problems of the Galaxiidae', by E. O. G. Scott, B.Sc.

'The Morphology of the Head of Homoptera', by J. W. Evans, M.A., F.R.E.S.

'Colour Variations and Distribution of the Tasmanian Brush Opossum', by J. Pearson, D.Sc., F.R.S.E., F.L.S.

'A Record of Volcanic Activity in Tasmania during Triassic Times', by A. N. Lewis. M.C., LL.D., and A. H. Voisey, M.Sc.

'The Male Meiotic Cycle in the Genus Eucalyptus', by A. L. McAulay, F.Inst.P., and F. D. Cruickshank, B.Sc.

'Evidence for the Existence of a Natural Hybrid between *Eucalyptus globulus* and *Eucalyptus ovata*', by A. L. McAulay, F.Inst.P.

'The Hybridization of the Eucalypts', by R. G. Brett, B.Sc.

'Aboriginal Rock Carvings Found at Trial Harbour', by J. F. Jones.

The Fifth R. M. Johnston Memorial Lecture was delivered by Sir David Rivett, K.C.M.G., M.A., D.Sc., Chief Executive Officer of the Council for Scientific and Industrial Research. Before the lecture His Excellency the Governor presented the R. M. Johnston Memorial Medal to Sir David Rivett. Sir David delivered a lecture on Wool, an account of which will be published in next year's Papers and Proceedings.

After the lecture a conversazione was held in the Art Gallery.

Northern Branch

Annual Report, 1937

The 1937 session was one of the most successful yet experienced. An outstanding event was the completion of the Fall-Hartnoll Memorial Wing at the Queen Victoria Museum and Art Gallery, as a result of which the Branch found, for the first time in its history, a definite home. Permission has been given by the Launceston City Council for the Branch to make the library and lecture-room in the new wing its permanent headquarters. Ordinary monthly meetings and Council meetings are now held here; and, with shelf-space available, the Branch is now attempting to organise and extend its library. Arrangements have been made during the present session for a varied selection of current scientific periodicals to be forwarded in monthly batches from the parent Society, and to be laid on the table for the convenience of members in the Branch's room.

The May meeting was held at the Public Library, the June meeting at the State High School, and the remaining meetings at the Museum.

24th May, 1937

Annual Meeting and Public Lecture

Mr. A. L. Meston presided. The following were elected as members of the Branch Council for 1937:—Mr. A. L. Meston (President), Hon. Tasman Shields, Messrs. R. S. Padman, F. Heyward, W. R. Rolph, J. E. Heritage, D. V. Allen, F. Smithies, J. R. Forward, E. O. G. Scott (Secretary). Mr. R. S. Padman was re-elected Honorary Auditor.

The statement of accounts, which disclosed a credit balance of £25 17s. 8d., was read and adopted.

The annual meeting was followed at 8 p.m. by a public meeting, arranged by the Tasmanian Branch of the Australian Forest League, in conjunction with the Branch. Addresses were given by Dr. Joseph Pearson ('Fauna and the Forests'), Mr. G. Wright ('Seasoning Processes of Timber'), Hon. Alan Wardlaw ('Objects of the Forest League'), Mr. C. E. H. Ferguson ('History of the Tasmanian Branch of the League'), Mr. F. Smithies (running commentary on two educational films, 'Lumbering in Canada' and 'Reafforestation').

17th June, 1937

Mr. A. L. Meston presided. Illustrated lecture: 'Creative Education', by Mr. A. Lismer, A.R.C.A., Educational Supervisor, Toronto Art Gallery. This meeting was open also to ticket-holders of the New Educational Fellowship.

19th July, 1937

Mr. A. L. Meston presided. Illustrated lecture: 'D'Entrecasteaux: An Account of His Life, His Expedition, and His Officers', by Dr. G. H. Hogg.

5th August, 1937

The Secretary presided. Illustrated lecture: 'Modern Museum Methods', by Mr. Frank Tose, Chief of Exhibits, California Academy of Sciences.

6th September, 1937

Mr. A. L. Meston presided. Illustrated lecture: 'Two Eyes as One', by Mr. R. S. Padman.

Council Meetings.

Meetings of the Council were held on 23rd April, 4th June, 6th July, 24th August, and 30th November.

NATIONAL MUSEUM OF VICTORIA

Walter E. Shimmins, Acting Government Printer, Tasmania

PAPERS & PROCEEDINGS

OF

THE ROYAL SOCIETY OF TASMANIA

FOR THE YEAR

1938

NATIONAL MUSEUM
5 JUNE 1939
VICTORIA.

Edited by

JOSEPH PEARSON, D.Sc. (Manc.), D.Sc. (Liverpool), F.R.S.E., F.L.S.

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NATIONAL MUSEUM OF VICTORIA

Pap. & Proc. Roy. Soc. Tasmania. 1938 (11th November, 1938.)

NATIONAL MUSEUM OF VICTORIA

Australian Leaf-Hoppers (Homoptera, Jassoidea)

Part VIII

By

J. W. Evans, M.A., F.R.E.S.

In the present paper on Australian Leaf-Hoppers, the following families are dealt with: Cicadellidae, Nirvaniidae, Euacanthidae, and the Euscelidae, in part. In addition, notes are given on the Paropiidae, Pythamidae, Jassidae, and Eupterygidae.

The purpose of this and of preceding papers has been to collect together references scattered in numerous periodicals extending over a century, to revise the classification where necessary, to enable students to obtain some idea of the jassoid fauna of the continent, and, primarily, to render it possible for entomologists other than specialists in the group, to place in their correct families and genera the commoner representatives of this super-family which are taken in general collecting.

To date 421 species, 66 of which are believed to be synonyms, contained in 108 genera, 79 of which are peculiar to the region, have been described from Australia. It is probable that approximately three-quarters of the available genera have been defined, but it is unlikely that more than one-half of the Australian species have yet been described.

CICADELLIDAE

The Cicadellidae, which are poorly represented in Australia, are of world-wide distribution, being especially abundant in South America. All the Australian species are placed in the type genus, since, although they might well be separated into three genera, such a course would be unwise without a knowledge of foreign forms.

Cicadella Latreille

Cuvier's Régne Animal, III.; 406, 1817.

Genotype **Tetigonia viridis L.**

This genus comprises cylindrically-shaped insects that have the fronto-clypeus swollen and extending on to the crown of the head. The ocelli are dorsal in position and occur at the apices of the frontal sutures, and there is no suture present between the fronto-clypeus and the vertex. The pronotum is broad and the propleurae widely separate the eyes from the bases of the tegmina. The tegmina are long and narrow, the venation is frequently obscure, and the appendices, which are narrow, extend to the apices of the tegmina. The hind tibiae have three rows of long spines with or without minute spines between each of the stoutest spines, and the male genitalia have broad pygophores with or without processes, and parameres that are much shorter than the sub-genital plates.

Ten species have been described previously from Australia and one South African species incorrectly recorded from Australia. Of the named species, four are unknown to me, one is a synonym, and *C. parthaon* Kirk. has been figured previously. The remaining species are figured, and in addition six new species are described below.

Cicadella coerulescens (Fabr.)

Cicada coerulescens F., 1803, Syst. Rhyng. 74.
Aulacizes dives Walk., 1851, List Homopt. III.; 791.
Tettigonia coerulescens Sign., 1853, Ann. Soc. Ent. Fr. (3) 1; 672.

Kirkaldy (1907) has suggested that the above species does not belong to this genus.

Cicadella quadrata (Walk.)

Tettigonia quadrata Walk., 1851, List Homopt. III., 781.

Cicadella perkinsi (Kirk.)

Tetigonia perkinsi Kirk., 1906. Hawaii Sug. Ass. Bull. 1 (9); 319.

Cicadella latromarginata (Dist.)

Tetigoniella latromarginata Dist., 1917, Ann. Mag. Nat. Hist. 20; 190.

Cicadella albomarginata (Sign.) (Plate I, fig. 5)

Tettigonia albomarginata Sign., 1853, Ann. Soc. Ent. Fr. (3) 1; 347.
Tetigonia pettimolua Kirk., 1906, Hawaii Sug. Ass. Bull. 1 (9); 362.

Cicadella koebelei (Kirk.) (Plate I, figs. 3a-d)

Tetigonia koebelei Kirk., 1906, Hawaii Sug. Ass. Bull. 1 (9); 319.

Cicadella pasiphae (Kirk.) (Plate I, figs. 1a-d)

Tetigonia pasiphae Kirk., 1906, Hawaii Sug. Ass. Bull. 1 (9); 320.

Cicadella parthaon (Kirk.)

Tetigonia parthaon Kirk., 1906, Hawaii Sug. Ass. Bull. 1 (9); 321.

Cicadella richmondensis (Dist.) (Plate I, fig. 11)

Tetigoniella richmondensis Dist., 1917, Ann. Mag. Nat. Hist. 20; 190.

Cicadella albida (Walk.)

Tettigonia albida Walk., 1851, List Homopt. III., 767.

The last named species was originally described from South Africa, and later recorded from India and Australia by Signoret (1853), and Kirkaldy (1906). In 1907 Distant pointed out that the Oriental species was distinct from the African one and proposed the new name *spectra* Dist. for the Oriental species. Mr. China has informed me that neither of these species are represented in the Australian fauna.

Cicadella angustata, sp. nov.

(Plate I, figs. 2, 10)

Length, 8 mm. *Head*, facially pale yellowish-brown, with a central dark-brown stripe on the fronto-clypeus, and with a series of narrow transverse brown stripes laterally. Crown of head and *pronotum* pale yellowish-brown, with dark-brown markings. *Scutellum*, marked with a pattern of dark-brown and yellowish-brown. *Tegmen*, hyaline-brown or dark greenish-black, the costal border narrowly white; venation indistinct. *Thorax* and *abdomen*, ventral surface ochreous.

Type ♂, from National Park, Queensland (coll. H. Hacker), in the collection of the Queensland Museum.

Cicadella heroni, sp. nov.

(Plate I, fig. 7)

Length, 8 mm. *Head*, facially egg-yellow, with two wide brown longitudinal stripes on the fronto-clypeus. Crown of head, *pronotum*, and *scutellum*, yellow, with brown markings. *Tegmen*, dull metallic green, the costal border white; venation indistinct. *Thorax* and *abdomen*, ventral surface, pale yellow.

Type ♀, from Ulong, East Dorrigo, New South Wales (Coll. W. Heron), in the collection of the Australian Museum, Sydney.

Cicadella naomiae, sp. nov.

(Plate I, fig. 9)

Length, 6 mm. *Head*, facially pale lemon-yellow, the ante-clypeus with a broad median longitudinal brown stripe, and the fronto-clypeus with two indistinct lateral stripes; antennal pits, deep. Crown of head, *pronotum*, and *scutellum*, yellow with black markings. *Tegmen*, dull bronze, costal border narrowly black fringed with white; veins with minute raised dots. *Thorax* and *abdomen*, ventral surface pale yellow. *Legs*, pale brown.

Type ♂, from Seven Mile Beach, Tasmania (coll. J.W.E.), in the collection of the Australian Museum, Sydney.

Cicadella sidnica, sp. nov.
(Plate I, fig. 12)

Length, 6 mm. *Head*, ventral surface with the ante-clypeus and fronto-clypeus black medially; the black area widens posteriorly and extends across the head above the antennal ledges; rest of the facial surface of the head yellow, but for a narrow dull-brown area in the centre of the fronto-clypeus anteriorly. Crown of head and *pronotum* marked with a pattern of yellow and black. *Scutellum*, black, the apex brown. *Tegmen*, greenish black, the costal border hyaline-brown. *Thorax* and *abdomen*, ventral surface, yellow. *Legs*, pale yellowish-brown, spines on the hind tibiae dark brown and black.

Type ♂, from Sydney New South Wales (coll. J.W.E.), in the collection of the Australian Museum, Sydney.

Cicadella markei, sp. nov.
(Plate I, figs. 4, 8)

Length, 7 mm. *Head*, ventral surface ochreous, with or without a broad median stripe on the ante-clypeus, and two brown stripes on the fronto-clypeus. Crown of head and *pronotum*, bright ochreous yellow with black markings. *Scutellum*, ochreous, with the anterior angles black. *Tegmen*, black; costal margin narrowly black, with a broad yellowish-green stripe posterior to the black border. *Thorax* and *abdomen*, ventral surface ochreous. *Legs*, very pale brown, spines somewhat darker brown.

Type ♂, from Dover, Tasmania (coll. J.W.E.), in the collection of the Australian Museum, Sydney.

Cicadella dianae, sp. nov.
(Plate I, fig. 6)

Length, 8 mm. *Head*, ventral surface brownish-yellow, with markings similar to those described for *C. markei*. Crown of head and *pronotum*, pale brownish-yellow, with black markings. *Scutellum*, sordid yellow, anterior angles black. *Tegmen*, black, apically brownish-grey. *Thorax* and *abdomen*, ventral surface, and legs, sordid yellow.

Type ♀, from National Park, Tasmania (coll. A. M. Lea), in the collection of the Australian Museum, Sydney.

NIRVANIIDAE.

The Nirvaniidae, which have their headquarters in the Oriental region, are poorly represented in Australia. In a key to the various jassoid families given by Baker (1923), they are defined as leaf-hoppers, in which the upper margin of the face is not extended beyond the margin of the vertex and not visible in dorsal view, or only a little just in front of the eyes. The ocelli are on the anterolateral

border of the head, or just above or below it, the lorae are small and narrow, and the antennae are usually inserted distinctly above the eyes in facial view, rarely on the upper line of, or between, the eyes, in which case the head is produced. The tegmina are usually without ante-apical cells, and the venation is seldom distinct basally.

Only one insect belonging to this family has previously been described from Australia. This species, *Macroceratogonia aurea* Kirk. was considered by Kirkaldy (1906) to be an aberrant Cicadellid. but has been placed by Baker in the Macroceratogoniinae, one of the three subfamilies of the Nirvaniidae. Three new species are described below, all belonging to genera that are included in the Nirvaniinae. Baker has pointed out that the descriptions of *Nirvana* Kirk. and *Ophiuchus* Dist. are inadequate, hence it is possible that the species placed in these genera may not be congeneric with the genotypes. They do appear to be congeneric with the species described by Baker, which he attributed to these genera.

Nirvana Kirkaldy

Entomologist 33; 293, 1910.

Genotype **Nirvana pseudommatos**, Kirk.

Baker, in his key to the genera of the Nirvaniinae, states that species in the genus *Nirvana* have the 'front' depressed only apically. Although the species described below has the 'front' evenly convex, it would appear to be congeneric with those described by Baker.

Nirvana adelaideae, sp. nov.

(Plate II, fig. 2)

Length, 6 mm. *Head*, ventral surface greenish-yellow, with two median black spots at the posterior apex; maxillary plates narrow; antennae long, antennal pits distinct, but not deep. Fronto-clypeus evenly convex, with a median carina posteriorly. Margin of head with an ill-defined carina that separates the fronto-clypeus from the vertex. Dorsal surface of head greenish-yellow, with a median black stripe that extends posteriorly onto the thorax. Crown convex; ocelli equally visible in dorsal and lateral aspects. *Pronotum*, collar-like, almost parallel-sided. *Tegmen*, hyaline, partially suffused with yellowish-brown, with an ante-apical hyaline-white fascia and a small brown marking at each end of the fascia. *Thorax*, ventral surface, yellow. *Legs*, pale green, but for the hind femora, which are yellow, and the tarsal claws, which are dark brown. Hind tibia, with three rows of long spines and with a few minute spines set between the most widely-spaced spines. *Abdomen*, ventral surface, yellowish-green; ovipositor sheath spinous.

Type ♀, from Waterfall Gully, Adelaide, South Australia (coll. J.W.E.), in the collection of the Australian Museum, Sydney.

Kana Distant

Faun. Brit. India, Rhynch. 4, 285, 1908.

Genotype **Kana thoracica** Dist.

Kana derrigensis, sp. nov.

(Plate II, figs. 1 a-b)

Length, 6 mm. *Head*, ventral surface, pale whitish-yellow; maxillary plates, wide; antennae, short, antennal pits, deep, close to the posterior apex of the head; fronto-clypeus, concave. Apical border of head wider against the eyes than in the centre; crown separated from the fronto-clypeus by a distinct carina. Crown of head, with three orange longitudinal stripes and two white stripes that continue onto the pronotum, blunt apically, and very slightly concave, so that the ocelli are visible laterally as well as dorsally. *Pronotum* not parallel-sided: both the head and pronotum are slightly declivous. *Tegmen*, pale orange-brown, with a row of black, white, orange, and white markings against the costal border close to the apex, and a diffuse black marking in both the apical median and cubital cells. *Thorax* and *abdomen*, ventral surface, yellowish-white.

Type ♀, from Dorrigo, New South Wales, in the collection of the South Australian Museum.

Ophiuchus Distant

Faun. Brit. India, Rhynch. 7, 334; 1918.

Genotype **Ophiuchus princeps** Dist.

Ophiuchus pallidus, sp. nov.

(Plate II, fig. 3)

Length, 6 mm. General coloration pale yellowish-white. *Head*, ventral surface, maxillary plates wide, fronto-clypeus convex anteriorly, concave posteriorly; antennae long. Apex of head flattened, of even width throughout, apical carina distinct. Crown of head spatulate, anteriorly flat, posteriorly inclined; ocelli only visible dorsally. *Tegmen*, milky-white, venation distinct.

Type ♀, from Stewart River, Queensland (coll. Hale and Tindale), in the collection of the South Australian Museum.

EUPTERYGIDAE

A list of the described Australian Eupterygidae was published by Myers in 1928, and since that date no new species have been added. Dumbleton (1934) has shown that *Typhlocyba froggatti* Baker (*australis* Froggatt) is an introduced European species, and not a member of the indigenous fauna. Only fifteen species have been described from Australia, but the family is well represented here. The difficulty experienced in deciding whether a species is indigenous or introduced, together with the involved synonymy, has acted as a

deterrent to the description of new species. However, their increasing importance as suspected vectors of virus diseases, and the recent publication of Ribaut (1937), should serve to awaken interest in this group.

Fig. 1.—*Megopthalmus scanicus*, head.
Fig. 2.—*Megopthalmus scanicus*, tegmen.

PAROPIIDAE

Only one genus, represented by a single species, has been described from Australia. This species, *Kahavalu gemma* Kirk., has been adequately described by Kirkaldy (1906). The Paropiidae may be recognized by their characteristic deep thimble pitting sculpture. The ocelli lie in deep grooves at the apical margin of the head, and the hind tibiae have a few small spines and hairs on the apical half. To enable the recognition of members of this family, figures are given of a European representative, *Megopthalmus scanicus* Fall., no specimens of *K. gemma* being available to the author.

JASSIDAE

Tharra labena Kirk. (1906) is the sole representative of this family so far described from Australia. Kirkaldy suggested that his genus *Tharra* was possibly only a group of *Jassus* Fabr. No specimens of *T. labena* being available for study, figures are given of *Jassus indicus* Walk. and *Jassus olitorius* Say.

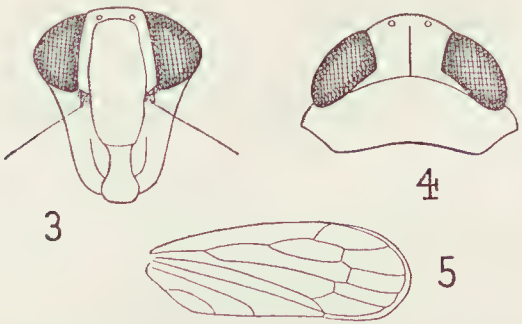

Fig. 3.—*Jassus indicus*, head.
Fig. 4.—*Jassus olitorius*, head and prothorax.
Fig. 5.—*J. olitorius*, tegmen.

PYTHAMIDAE

Baker has included two of Kirkaldy's genera, each represented by a single species in this family. These are *Dryadomorpha pallida* Kirk. (1906) and *Tortor daulias* Kirk. (1907). Kirkaldy has figured the former (Plate 32, figs. 12-14). According to Baker, in all the genera of this family the pronotum is truncate or slightly incurved posteriorly; the anterolateral carinae of the vertex reach the apex, or nearly so; the sides of the front are very shallowly sinuate opposite the antennal scrobes, and the clypeus is strongly narrowed apically.

EUACANTHIDAE

The leaf-hoppers described below are the first members of this family to be described from Australia. They have superficial characters in common with both the Cicadellidae and the Euscelidae.

Euacanthella, gen. nov.

The head is arrow-shaped, the ante-clypeus much narrower anteriorly than posteriorly, the antennal scrobes distinct, but short, and the antennal pits deep. The crown of the head, which is slightly tilted dorsally at the apex, has a slight depression anteriorly, has always a coronal suture, and may have a transverse epicranial suture. The ocelli are on the crown, well away from the anterior margin. The pronotum is much narrower than the head, including the eyes, and the propleurae narrowly separate the eyes from the bases of the tegmina. The scutellum is small. Both brachypterous and fully-winged forms occur, and the tegmina of the winged forms are narrow.

Euacanthella palustris, sp. nov. (Genotype)

(Plate III, figs. 8 a-c)

Length, 8 mm. *Head*, ventrally black, mottled sparsely with pale brown; eyes, pale brown. Crown produced anteriorly, dark brown, mottled with yellowish-brown. Anterior third of crown divided from the posterior two-thirds by a transverse ridge. *Pronotum* concolorous with the crown. *Scutellum*, dark brown, with two more or less oval yellow markings. *Tegmen* reaching as far as the first abdominal segment; wings not developed. *Thorax* and *abdomen* and *legs*, very dark brown, mottled with pale brown.

Type ♀, from Snug, Tasmania (coll. J.W.E.), in the collection of the Australian Museum, Sydney.

Euacanthella insularis, sp. nov.

(Plate III, figs. 9 a-b)

Length, 8 mm. *Head*, pale yellow, suffused with an irregular pale brown pattern; on the crown an indistinct transverse ridge. *Pronotum*, concolorous with the head. *Scutellum*, yellow. *Tegmen*, short, as with *E. palustris*; wings not developed. *Thorax*, *abdomen* and *legs*, pale yellow with a faint irregular pattern of very pale brown. *Male Genitalia*, with a long, narrow process arising from the base of the ventral surface of the pygophore, and a short hooked-shaped process arising from the dorsal surface of the pygophore.

Type ♂, from Hobart, Tasmania (coll. J.W.E.), in the collection of the Australian Museum, Sydney.

Euacanthella bicolor, sp. nov.

(Plate III, figs. 10 a-c)

Length, 5·5 mm. *Head*, ventrally, brown mottled with yellowish-brown, crown slightly paler in colour. *Pronotum*, concolorous with the crown. *Tegmen*, fully developed, pale hyaline-brown, veins, white, wings developed. *Thorax* and *abdomen*, ventral surface white, mottled with grey. Fore and middle *legs* pale brown; hind legs white, spurs brown. *Male Genitalia*, with a long process arising from the base of the pygophore.

Type ♂, from Snug, Tasmania (coll. J.W.E.), in the collection of the Australian Museum, Sydney.

EUSCELIDAE

In previous papers (Evans, 1936, a, b) the arboreal Australian Euscelidae have been described, and one tribe, the Paradorydiini, of the sub-family Eupelicinae. The remaining representatives of the family are largely confined to grasses, and are especially abundant in swamp environments.

Representatives of fifteen genera have previously been described from Australia; four new ones are described below. Of these, ten are apparently confined to the Australian region.

EUPELICINAE

The genus defined below is provisionally placed in the Eupelicinae, but its affinities are doubtful.

Euprora, gen. nov.

The head is produced, narrowing anteriorly and the ocelli are marginal, slightly in front of the eyes. On the crown of the head are ill-defined carinae, that extend from the ocelli in an anterior

direction, and meet in a mid-line slightly posterior to the apex of the head. The pronotum is flat, on a plane with the crown of the head, and the propleurae narrowly separate the eyes from the bases of the tegmina. The tegmina are long and narrow, taper posteriorly, and extend well beyond the apices of the abdomen. The hind tibiae have three rows of spines; those of one row are set on enlarged bases, and are separated from each other by a few minute spines.

Euprora mullensis, sp. nov.

(Plate II., figs. 8 a-c)

Length, 11 mm. General coloration, pale yellowish-brown. *Head*, with longitudinal striations; eyes, reddish-brown. *Tegmen*, hyaline, tibiae, with the bases of the row of largest spines, black.

Type ♀, from Mullewa, Western Australia (coll. F. May), in the collection of the South Australian Museum.

EUSCELINAE

HECALINI

Reuteriella Signoret

Reuteria Sign., 1879, Ann. Soc. Ent. Fr. IX.; 51 (preoccupied).
Reuteriella Sign., 1880, Ann. Soc. Ent. Fr. X.: 45.

This genus, which is re-described below, superficially resembles *Selenocephalus* Germ.

The ventral surface of the head is almost flat and the lorae are small, not nearly reaching to the anterior margin of the head. The antennal scrobes are raised into a distinct ridge that extends from the margin of the head on each side, just posterior to the eyes, to beyond the apex of the clypeal suture. The head is flattened apically into a narrow flat rim, which is more or less at right-angles to the dorsal and ventral surfaces of the head. The ocelli are situated on this rim at a short distance in front of the eyes. The crown of the head, which is produced, is flat or slightly transversely concave. The pronotum widens posteriorly, and the propleurae widely separate the eyes from the bases of the tegmina. The tegmina, which overlap posteriorly, have wide appendices, and the hind tibiae, which are flattened, lack minute spines set between each of the largest spines.

Reuteriella flavescens Sign. (Genotype)

(Plate II., figs. 4 a-b)

Ann. Soc. Ent. Fr. X; 365, 1880.

Reuteriella hobartensis, sp. nov.

(Plate II., figs. 5a, b)

Length, 6·5 mm. *Head*, pale lemon-yellow, rounded anteriorly; eyes, dark brown. *Pronotum*, anterior two-thirds yellow, posterior third, and *scutellum*, pale brown. *Tegmen*, hyaline, costal border, pale yellow, the remainder pale yellowish-brown. *Thorax* and *abdomen*, ventral surface and *legs*, pale yellow.

Type ♀, from Hobart, Tasmania (coll J.W.E.), in the collection of the Australian Museum, Sydney.

Hecalus Stål

Ann. Soc. Ent. Fr. (4) IV.; 65, 1864.

Two species belonging to this genus have been described previously from Australia. These are *Hecalus pallescens* Stål (1864), which has been figured by Signoret (1879), and *H. immaculata* Kirk. (1906), which is a brachypterous form. Two new species are described below.

Hecalus basedowi, sp. nov.

(Plate II., figs. 6a, b)

Length, 9 mm. General coloration evenly yellowish-white, eyes, pale brown. *Head*, ventral surface convex, apically foliaceous. Crown spatulate, widely rounded apically. *Tegmina*, fully developed, overlapping slightly apically, and extending almost to the apex of the abdomen; appendix wide.

Type ♀, from Western Australia (coll. H. Basedow), in the collection of the Australian Museum, Sydney.

Hecalus elongatus, sp. nov.

(Plate II., fig. 7)

Length, 10 mm. General coloration yellowish-green, eyes, red. This species differs from the preceding in that the head is more spatulate, narrower apically, and produced further anteriorly.

Type ♀, from Western Australia (coll. H. Basedow), in the collection of the Australian Museum, Sydney.

XESTOCEPHALINI

Xestocephalus Van Duzee

Xestocephalus Van Duzee, 1894, Bull. Buff. Soc. Nat. Sci. 5; 197.
Myrmecophryne Kirkaldy, Hawaii Sug. Ass. Bull. 1 (9); 461.

A comparison of a paratype of *Myrmecophryne formiceticola* Kirk. with *Xestocephalus pulicarius* Van D. has shown that the two species are congeneric. Two other species belonging to this genus have been described previously from Australia, these are *X. australiensis* Kirk. and *X. sidnicus* Kirk. (1907). One new species is described below.

Xestocephalus tasmaniensis, sp. nov.

(Plate II, fig. 9)

Length, 2 mm. *Head*, ventral surface reddish-brown, palest posteriorly; antennae very long; crown, declivous, rounded apically, reddish-brown with yellow markings; ocelli marginal, visible dorsally, large and white. *Tegmen*, pale yellowish-brown, with brown areas surrounding oval hyaline spots. *Thorax*, ventral surface chocolate-brown. *Abdomen*, ventral surface brown, the hind border of each segment white.

Type ♂, from Hobart, Tasmania (coll. A. M. Lea), in the collection of the Australian Museum, Sydney.

EUSCELINI

Tasmanotettix, gen. nov.

The ventral surface of the head is evenly convexly rounded, the antennal pits are shallow, and the antennae long. The internal margins of the eyes lie close to the frontal suture on each side, and, apically, the head lacks a flattened margin. The ocelli are visible in dorsal aspect and lie close to, but not touching, the eyes, and the width of the crown is less than the width of each eye. The anterior margin of the pronotum is evenly rounded, and the propleurae are narrow. The tegmina, which are long and narrow, extend well beyond the apex of the abdomen. The hind tibiae are flattened, and the small spines, which are set between the bases of the largest spines, are distinct and numerous.

Tasmanotettix maculata, sp. nov. (Genotype)

(Plate III, fig. 1)

Length, 6 mm. *Head*, ventrally, very dark brown, but for the fronto-clypeus and the edges of the lorae, which are somewhat paler. Crown, mottled, with a regular pattern of dark brown, pale coffee-brown and yellow; ocelli, red. *Pronotum*, black, with six small white

areas lying transversely against the anterior border, posteriorly flecked with yellowish-grey. *Scutellum,* brown with four white markings. *Tegmen,* dark brown, with hyaline-white oval, and irregularly-shaped areas; veins, dark brown, bordered with yellowish-brown. *Thorax* and *abdomen,* ventral surface black, each abdominal segment narrowly edged with white posteriorly. *Legs,* dark brown, the hind tibiae ornamented with pale and dark-brown spots.

Type ♀, from Hobart, Tasmania (coll. J.W.E.), in the collection of the Australian Museum, Sydney.

Diemoides, gen. nov.

The ventral surface of the head is evenly convexly rounded, the antennal pits are shallow, and the apical margin of the head is broad. The ocelli, which are on the upper border of the apical margin, are well in front of the eyes, but closer to the eyes on each side than to each other. The dorsal surface of the head is arrow-shaped, the coronal suture is distinct, and the width of the crown is greater than that of the eyes. The pronotum, of which the anterior margin is almost straight between the eyes, is narrow laterally, and the propleurae separate the eyes from the bases of the tegmina. The tegmina have narrow appendices and the anal veins are fused medially. The hind tibiae have a few very minute spines set between the bases of each of the largest spines.

Diemoides smithtoniensis, sp. nov. (Genotype)

(Plate III, fig. 4)

Length, 4 mm. *Head,* ventrally, pale brown, apical margin with three black and two white transverse stripes; ocelli, red. Crown, white suffused with pink medially. *Pronotum,* bright red anteriorly, grey posteriorly. *Scutellum,* with the anterior angles red, the remainder white. *Tegmen,* hyaline, with brown areas between the veins and the costal margin partly white; border of tegmen and anal veins red, other veins brown. *Thorax* and *abdomen,* ventral surface black with white markings. *Legs,* white with black markings.

Type ♀, from Smithton, Tasmania (coll J.W.E.), in the collection of the Australian Museum, Sydney.

Eutettix Van Duzee

Trans. Amer. Ent. Soc. 19; 302, 1892.

One species (*melaleucae* Kirk., 1907), belonging to this genus, has been described previously from Australia, and a widely distributed species, *sellata* (Uhler) (Kirkaldy, 1906), has been recorded from Queensland. Three new species are described below. The figures render unnecessary a re-description of this genus.

Eutettix norrisi, sp. nov.

(Plate III, figs. 2 a-d)

Length, 6 mm. *Head*, ventral surface, pale biscuit-colour; muscle impressions on the fronto-clypeus dark brown; eyes very dark brown. Crown of head slightly wider in the middle than against the eyes, with a median black transverse stripe just posterior to the ocelli, which, although marginal, are visible in dorsal aspect. *Pronotum*, pale greyish-brown, with a few dark-brown spots. *Scutellum*, pale yellow. *Tegmen*, transparent, veins dark brown, anal border dark brown, appendix wide. *Thorax* and *abdomen*, ventral surface, yellowish-white with a few irregular dark-brown markings. Hind tibiae, with four rows of spines and with minute spines set between the bases of each of the largest spines.

Type ♂, from Crawley, Western Australia (coll. K. R. Norris), in the collection of the Australian Museum, Sydney.

Eutettix pallida, sp. nov.

(Plate III, fig. 3)

Length, 6 mm. *Head*, ventral surface pale yellow or brown; muscle impressions paler in colour than the rest of the fronto-clypeus; eyes dark brown. Crown slightly wider in the middle than against the eyes, with a pale dark brown transverse stripe. *Pronotum*, pale yellowish-brown. *Scutellum*, yellow. *Tegmen*, including the veins, transparent. *Thorax* and *abdomen*, ventral surface pale yellow.

Type ♀, from Stewart River, Queensland (coll Hale and Tindale), in the collection of the South Australian Museum.

Eutettix selbyi, sp. nov.

Length, 7 mm. *Head*, ventral surface, pale whitish-yellow, but for the eyes, which are red, the ante-clypeus, fronto-clypeus anteriorly, and the muscle impressions, which are coffee-coloured, and two transverse black markings on the fronto-clypeus posteriorly. Crown of head, pale yellow, with two pairs of transverse black markings that do not reach as far as the eyes laterally, nor as far as the coronal suture medially, nearly as wide against the eyes as in the middle; ocelli marginal, visible in dorsal aspect. *Pronotum*, grey, with three small dark-brown markings lying behind each eye. *Scutellum*, yellowish-grey, with a dark brown V-shaped marking close to each anterior angle. *Tegmen*, white, brown apically, and with brown areas between the veins; veins dark brown. *Thorax* and *abdomen*, ventral surface, and *legs* marked with a pattern in yellow, pale and dark brown. Ovipositor sheath in the female, dark brown with white spines.

Type ♀, from Mutchilba, North Queensland, in the collection of Mr. F. E. Wilson, Melbourne.

Thamnotettix Zetterstedt

Ins. Lapp. 29; 1840.

The two species described below are the first belonging to this widely distributed genus to be described from Australia.

Thamnotettix argentata, sp. nov.

(Plate III, fig. 5)

Length, 3·5 mm. *Head*, pale yellow, marked with an irregular dark-brown pattern; eyes, dark brown. *Pronotum*, anterior, third pale yellow, posterior, two-thirds grey, flecked with transverse dark-brown markings. *Scutellum*, yellow, but for the apex, which is dark brown. *Tegmen*, hyaline, with a silvery appearance, due to the sheen of the underlying wings, patterned with an irregular network of dark-brown markings. *Thorax* and *abdomen*, ventral surface, pale yellow with scattered dark-brown markings.

Type ♂, from Burnley, Victoria (coll. J.W.E.), in the collection of the Australian Museum, Sydney

Thamnotettix canberrensis, sp. nov.

(Plate III, fig. 6)

Length, 3 mm. General coloration pale yellow, eyes, dark brown, ocelli, red. *Head*, very pale yellow, crown much wider medially than against the eyes. *Pronotum* and *scutellum*, apricot yellow. *Tegmen*, hyaline-yellowish, extending beyond the apex of the abdomen.

Type ♀, from Canberra, F.C.T. (coll J.W.E.), in the collection of the Australian Museum, Sydney.

Phrynophyes Kirkaldy

Hawaii Sug. Ass. Bull. 1 (9); 327, 1906.

Two species of this genus, *phyrnophyes* Kirk. and *parvula* Kirk., have been described previously from Australia. The figures given by Kirkaldy make re-description of this genus unnecessary.

Phrynophyes kirkaldyi, sp. nov.

(Plate III, figs. 7a-c)

Length (♀), 5 mm. General coloration, when alive, metallic green. *Head*, ventral surface, pale yellowish-brown; muscle impressions on the fronto-clypeus transverse, brown; eyes, dark green. Crown, pale yellowish-green, pointed apically, distance between the anterior corners of the eyes greater than between the internal posterior corners; ocelli, visible in dorsal aspect, minute. *Pronotum* and *scutellum*, yellowish-green. *Tegmen*, hyaline, olive-green, costal

border whitish-green, veins outlined in brown. *Thorax*, ventral surface, and legs, pale yellowish-brown with dark-brown markings. *Abdomen*, ventral surface, marked with a variable pattern of light and very dark brown. The abdomen extends well beyond the apices of the folded tegmina in the female, but only slightly beyond in the male.

Type ♂, from Snug, Tasmania (coll. J.W.E.), in the collection of the Australian Museum, Sydney.

Deltocephalus Burmeister

Gen. Ins. 1838.

The following six species of this cosmopolitan genus have been described previously from Australia: *flavidiventris Stål* (1859), *perparvus* Kirk. (1906), *lotis* Kirk., *polemon* Kirk., *lucindae* Kirk. (1907), *aranda* Jacobi (1909). Two new species are described below.

Deltocephalus obliquus, sp. nov.

(Plate III, figs. 11a-c)

Length, 3 mm. *Head*, ventral surface, pale reddish-brown, darkening posteriorly; muscle impressions on fronto-clypeus black, oblique; eyes, black. Crown of head pointed apically; muscle impressions visible on small semi-circular areas lying on each side of the anterior margin of the head, between these impressions, crown, black; the remainder yellow, marked with a regular pattern of light and dark brown. *Pronotum*, short, anteriorly concolorous with the crown of the head, posteriorly grey. *Scutellum*, yellow, with two round black spots. *Tegmen*, hyaline-grey, with a few irregular dark-brown markings; veins, white. *Thorax* and *abdomen*, ventral surface, pale yellowish-brown; legs somewhat darker brown.

Type ♂, from Smithton, Tasmania (coll. J.W.E.), in the collection of the Australian Museum, Sydney.

Deltocephalus montanus, sp. nov.

(Plate III, fig. 12)

Length, 3 mm. *Head*, ventral surface, black, mottled with bright yellow: crown only slightly pointed apically, muscle impressions not extending onto the crown, marked with an irregular pattern of black and yellow; ocelli, red. *Pronotum*, yellowish-grey, flecked with transverse dark-brown markings. *Tegmen*, hyaline, greyish-brown; veins, white bordered with irregular dark-brown markings. *Thorax* and *abdomen*, ventral surface, black. *Legs*, marked with an irregular pattern of dark brown, yellow and black.

Type ♂, from Mount Lofty, South Australia (coll. J.W.E.), in the collection of the Australian Museum, Sydney.

Notes.

In addition to those described in this paper, the following genera are apparently confined to Australia:—

Anemochrea Kirk., 1906; genotype *A. mitis* Kirk.
Anemolua Kirk., 1906; genotype *A. hanuala* Kirk.
Giffardia Kirk., 1906; genotype *G. dolichocephala* Kirk.
Soracte Kirk., 1907; genotype *S. appollonos* Kirk.
Thamnophryne Kirk., 1907; genotype *T. nysias* Kirk.

Whilst it is possible that *Anemochrea* and *Anemolua* are related to *Euacanthella* (Euacanthidae), the remainder, with the exception of *Giffardia*, which may be related to *Euprora*, belong to the *Euscelini*.

The following species described from Australia belong to genera that are well represented in other zoo-geographical regions: *Driotura aristarche Kirk.* (1907); (paratype examined). Kirkaldy (1906) placed the following species in the genus *Phrynomorphus* Curtis, which is a synonym of *Euscelis* Brullé: *longuinquus* Kirk., *taedius* Kirk., *hospes* Kirk., *chlorippe* Kirk.

Limnotettix Sahl. contains three Australian species, *dimittendus* Kirk. (originally placed in the genus *Eulcimonios* Kirk.), *tachyporias* Kirk., and *capitatus* Kirk. *Lonatura* Osborn and Ball and *Scaphoideus* Uhler each contains a single Australian species, *L. austrina* Kirk. (1907) and *S. pristidens* Kirk. (1907). *Nephotettix* Matsumura contains two Australian species, *plebeius* Kirk. (1906) and *curytus* Kirk. (1907). Kirkaldy suggested that *N. plebeius* is an introduced species.

BALCLUTHINAE.

The following have been described from Australia:—*Nesosteles* Kirk. (1906), genotype *N. hebe* Kirk. (from Viti Isles); Australian species, *sanguinescens* Kirk., *sordidor* Kirk., *glauca* Kirk., and *taedia* Kirk., *Pettya* Kirk. (1906), genotype *P. anemolua* Kirk.

My attention having been drawn to the fact that *Ipocerus* Evans (1934) is preoccupied by *Ipocerus* Baker, type *Ipocerus kirkaldyi* (1915), the name of the former genus is hereby changed to *Bakeriola*, type *Bakeriola procurrens* (Jacobi).

References.

Baker, C. F., 1915.—*Phillipine Journ. Sci.* 10 (6).
———, 1923.—*Phillipine Journ. Sci.* 23 (4); 345.
Distant, W. L., 1907.—*Faun. Br. Ind. Rhyn.* IV.; 211.
Dumbleton, L. J., 1934.—*N. Z. Journ. Sci. & Tech.* 16 (1); 30.
Evans, J. W., 1934.—*Trans Roy. Soc. S. Aust.* 58; 149.
———, 1937 (a).—*Pap. Roy. Soc. Tas.* 1936; 37.
———, 1937 (b).—*Pap. Roy. Soc. Tas.* 1936; 51.
Jacobi, A., 1909.—*Faun. S.W. Aust.* (Michaelsen u. Hartmeyer); 340.

KIRKALDY, G. W., 1906.—*Hawaii Sug. Ass. Bull.* 1 (9).
———————, 1907.—*Hawaii Sug. Ass. Bull.* 3.
MYERS. J. G., 1928.—*Bull. Ent. Res.* 18 (1); 311.
RIBAUT, H., 1937.—*Faune de France*, 31.
SIGNORET, V., 1853.—*Ann. Soc. Ent. Fr.* (3) 1; 663.
———————, 1879.—*Ann. Soc. Ent. Fr.* IX.; 61 & 226.
STÅL, C., 1859.—*Eugenies Resa Ins.* 294.
————, 1864.—*Ann. Soc. Ent. Fr.* (4) IV.; 65.

PLATE I

Fig. 1a.—*Cicadella pasiphae*, wing.
Fig. 1b.—*Cicadella pasiphae*, tegmen.
Fig. 1c.—*Cicadella pasiphae*, head and thorax, dorsal aspect.
Fig. 1d.—*Cicadella pasiphae*, hind margin of last abdominal segment of ♀
Fig. 2.—*Cicadella angustata*, head.
Fig. 3a.—*Cicadella koebelei*, head and thorax, dorsal aspect.
Fig. 3b.—*Cicadella koebelei*, hind margin of last abdominal segment of ♀
Fig. 3c.—*Cicadella koebelei*, male genitalia.
Fig. 3d.—*Cicadella koebelei*, male genitalia.
Fig. 4.—*Cicadella markei*, hind tibia.
Fig. 5.—*Cicadella albomarginata*, head and thorax, dorsal aspect.
Fig. 6.—*Cicadella dianae*, head and thorax, dorsal aspect.
Fig. 7.—*Cicadella heroni*, head and thorax, dorsal aspect.
Fig. 8.—*Cicadella markei*, head and thorax, dorsal aspect.
Fig. 9.—*Cicadella naomiae*, head and thorax, dorsal aspect.
Fig. 10.—*Cicadella angustata*, head and thorax, dorsal aspect.
Fig. 11.—*Cicadella richmondensis*, head and thorax, dorsal aspect.
Fig. 12.—*Cicadella sidnica*, head and thorax, dorsal aspect.

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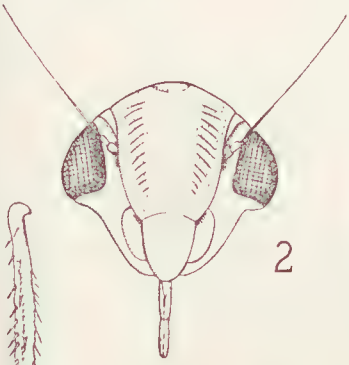
1b



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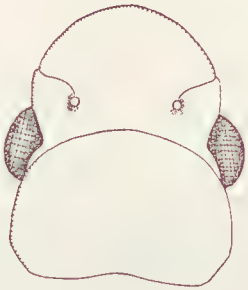

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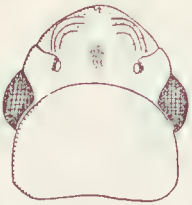

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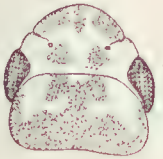

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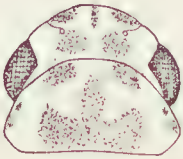

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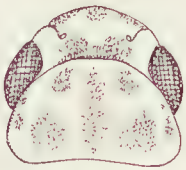

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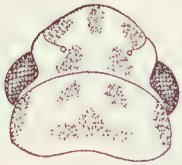

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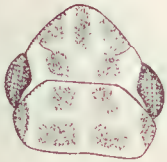

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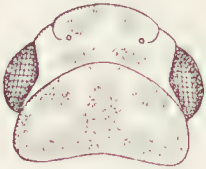

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Plate II

Fig. 1a.—*Kana dorrigensis*, head, ventral aspect.
Fig. 1b.—*Kana dorrigensis*, head and thorax, dorsal aspect.
Fig. 2.—*Nirvana adelaideae*, head and thorax, dorsal aspect.
Fig. 3.—*Ophiuchus pallidus*, tegmen.
Fig. 4a.—*Reuteriella flavescens*, hind tibia.
Fig. 4b.—*Reuteriella flavescens*, tegmen.
Fig. 4c.—*Reuteriella flavescens*, head in profile.
Fig. 4d.—*Reuteriella flavescens*, head and thorax, dorsal aspect.
Fig. 4e.—*Reuteriella flavescens*, head, ventral aspect.
Fig. 5a.—*Reuteriella hobartensis*, head, ventral aspect.
Fig. 5b.—*Reuteriella hobartensis*, head and pronotum, dorsal aspect.
Fig. 6a.—*Hecalus basedowi*, tegmen.
Fig. 6b.—*Hecalus basedowi*, head and pronotum, dorsal aspect.
Fig. 7.—*Hecalus elongatus*, head and pronotum, dorsal aspect.
Fig. 8a.—*Euprora mullensis*, head and pronotum, dorsal aspect.
Fig. 8b.—*Euprora mullensis*, head and pronotum in profile.
Fig. 8c.—*Euprora mullensis*, tegmen.
Fig. 9.—*Xestocephalus tasmaniensis*, head.

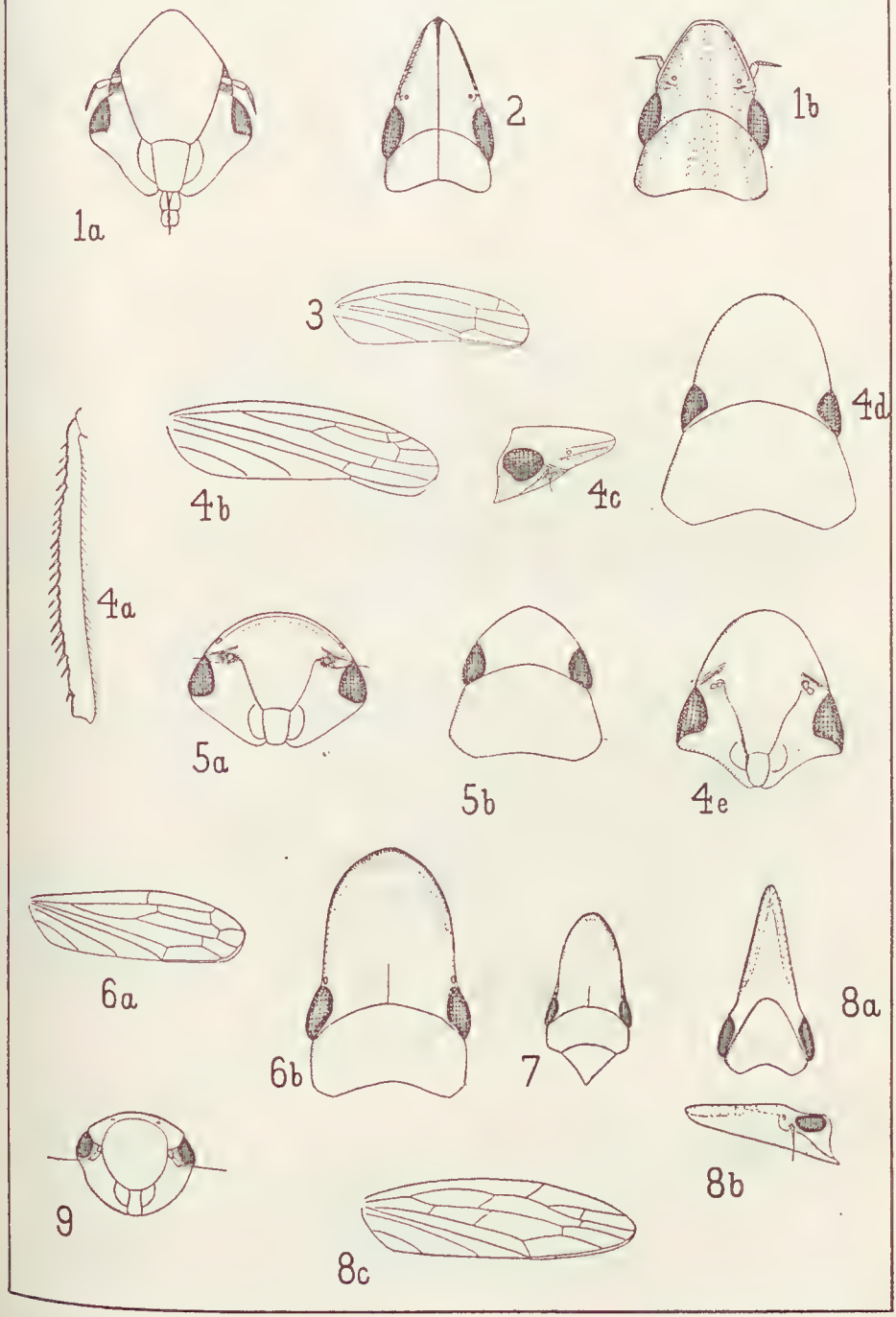
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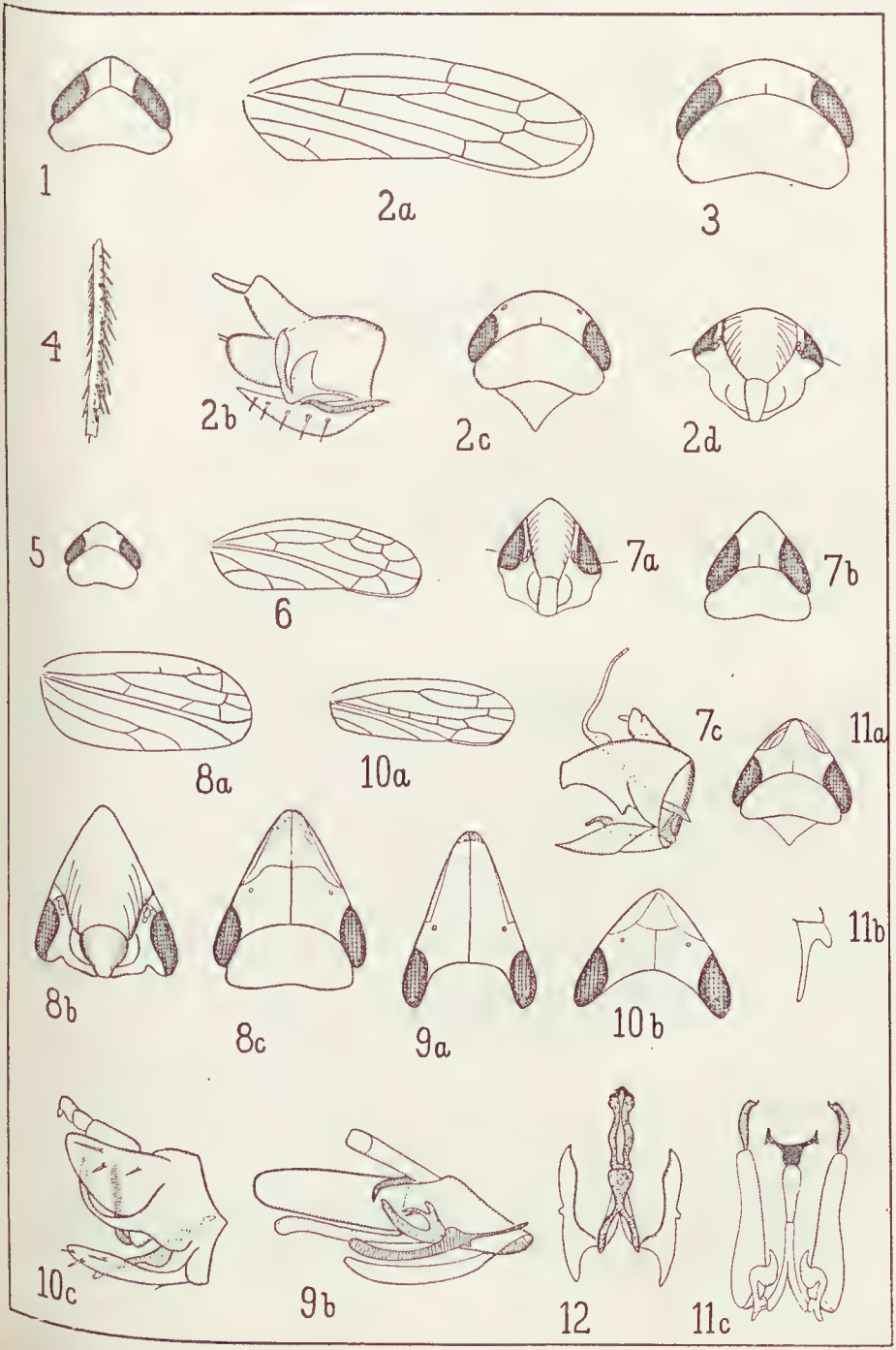
Plate III.

Fig. 1.—*Tasmanotettix maculata*, head and pronotum, dorsal aspect.
Fig. 2a.—*Eutettix norrisi*, tegmen.
Fig. 2b.—*Eutettix norrisi*, male genitalia.
Fig. 2c.—*Eutettix norrisi*, head and thorax, dorsal aspect.
Fig. 2d.—*Eutettix norrisi*, head, ventral aspect.
Fig. 3.—*Eutettix pallida*, head and pronotum, dorsal aspect.
Fig. 4.—*Diemoides smithtoniensis*, hind tibia.
Fig. 5.—*Thamnotettix argentata*, head and thorax, dorsal aspect.
Fig. 6.—*Thamnotettix canberrensis*, tegmen.
Fig. 7a.—*Phrynophyes kirkaldyi*, head, ventral aspect.
Fig. 7b.—*Phrynophyes kirkaldyi*, head and pronotum, dorsal aspect.
Fig. 7c.—*Phrynophyes kirkaldyi*, male genitalia.
Fig. 8a.—*Euacanthella palustris*, tegmen.
Fig. 8b.—*Euacanthella palustris*, head, ventral aspect.
Fig. 8c.—*Euacanthella palustris*, head and pronotum, dorsal aspect.
Fig. 9a.—*Euacanthella insularis*, head, dorsal aspect.
Fig. 9b.—*Euacanthella insularis*, male genitalia.
Fig. 10a.—*Euacanthella bicolor*, tegmen.
Fig. 10b.—*Euacanthella bicolor*, head, dorsal aspect.
Fig. 10c.—*Euacanthella bicolor*, male genitalia.
Fig. 11a.—*Deltocephalus obliquus*, head and thorax, dorsal aspect.
Fig. 11b.—*Deltocephalus obliquus*, last ventral abdominal segment of ♀
Fig. 11c.—*Deltocephalus obliquus*, male genitalia.
Fig. 12.—*Deltocephalus montanus*, male genitalia.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A Contribution to the Study of the Jassoidea (Homoptera)

By

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Introduction.

Some ten years ago a study was begun of the jassoid fauna of Australia. Since then group after group has been dealt with in turn, and, at present, it is believed that the principal divisions have been defined, although only a fraction of the actual genera and species have been described.

At an early stage of the investigation it was decided that the series of taxonomic papers should be followed by one in which not only would a key be given to the various families considered previously, but their inter-relationships would be discussed and a comparison made with the faunas of other zoo-geographical regions. The scope of the present paper, which is the final one in the series, is very different from that originally anticipated, because in recent years it has become increasingly clear that the classification adopted in the past is not a natural one. Thus, under the present classification, some families comprise genera in no way closely related to one another, and many genera with well-defined natural affinities are to be found in widely separated groups. Hence it has become necessary to rearrange the position of several genera and to discard certain of the criteria formerly used for the classification of the major groups.

This paper is concerned principally with Australian jassoids, but a few genera from other regions are included, as they assist in an understanding of the complexities involved. The number of families comprised in the Jassoidea must always remain a matter of personal opinion, as a family is an arbitrary unit. In the classification proposed it is realized that the various families are not of equal status.

Moreover there exists a number of groups of genera, representatives of which have either been unobtainable for study (e.g., *Adelungia* Mel. and related genera), or which are unknown to me, that have characteristics that are just as distinct as those considered here of sufficient importance to merit the raising of groups to family rank. Little attention is paid to divisions of lower status.

In order to assign a species to its correct family it is usually insufficient to take into account only one or two of its characters, but the insect must be regarded as a whole, and all its characteristics of structure, coloration, and sculpture examined and balanced. A key is not given, as it was found impossible to construct a concise one, but the figures should render the absence of a key unimportant.

The present writer, who is out of touch with libraries, is fully aware that he is not acquainted with all the literature concerned with jassoid classification, and that this work must be incomplete in certain respects. Nevertheless, it is believed that a study based on the leaf-hoppers of an important, though little-known, faunal zone, will be of assistance in helping to pave the way towards an understanding of some of the problems that have made the classification of this group of Homoptera one of the most complex in the whole insect kingdom.

Present Systems.

So many varied systems of classification have been proposed for the jassoid complex that little purpose would be served by a general review. Instead the systems of four workers are dealt with, three of which refer to particular geographical units.

The most recent is that of Ribaut (1936), who is concerned with the European fauna, and that of France in particular. Ribaut divides the Cicadoidea into seven families, the Membracidae, Cicadidae, Cercopidae, Scaridae, Ulopidae, Jassidae, and Typhlocybidae. The last four on the list are more closely related to one another than they are to any of the first three, or than are any of the first three to one another, and, whilst it might be accepted that four families are sufficient to include the limited fauna under consideration, if the Scaridae (Ledridae) merit separation, the Jassidae are certainly in need of subdivision. Whilst the character of a pronotum with dorsal protuberances may serve to define *Ledra aurita* L., it is not one of any value when applied to the family as a whole.

DeLong (1923), who described the fauna of a single State in Eastern North America, considers the Jassoidea as a single family, the Cicadellidae, and divides them into four sub-families, the Bythoscopinae, Jassinae, Cicadellinae, and Gyponinae. The sole character made use of to define the Bythoscopinae is that the ocelli are

on the front below the margin of the vertex, and the genera comprised in this family are *Agallia* Curtis, *Idiocerus* Lewis, *Macropsis* Lewis, *Oncopsis* Burm., and *Bythoscopus* Germ. The Jassinae are considered as including those leaf-hoppers that have the ocelli on the margin of the vertex, where such is definite, or on that portion of the head between the vertex and the front, where there is no perceptible limit to either. Three tribes, the Jassini, Acucephalini, and Typhlocybini are defined, and, whilst the lastnamed is separated on characters supplied by tegminal venation, the position of the ocelli is again made use of to differentiate the remaining two. Whilst only four genera are placed in the Acucephalini, twenty-five genera are comprised in the Jassini; amongst them are *Jassus* Fabr. and *Euscelis* Brullé. The Cicadellinae, which contain numerous American genera, are defined as having the ocelli on the disc of the vertex and the body cylindrical, not dorso-ventrally flattened, whilst the Gyponinae, although also having the ocelli on the disc of the vertex, have the body dorso-ventrally flattened. Three genera are placed in the Gyponinae: *Gypona* Germ., *Penthimia* Germ., and *Xerophloea* Germ.

Naudé (1926), in a memoir on the jassoid fauna of South Africa, divides the Cicadellidae into six sub-families, the Ulopinae, Ledrinae, Bythoscopinae, Cicadellinae, Gyponinae, and Jassinae, and also separates the last-named into Acucephalini, Jassini, and Typhlocybini.

The Ledrinae are defined in a key as having the hind tibiae four-cornered, usually armed with numerous spines, the eyes elliptical, more or less in line with the margin of the vertex, and the pronotum usually angularly extended laterally, whilst the Ulopinae have globular eyes standing out from the outline of the head and the pronotum rounded or straight laterally. Other points to be noted are that a genus *Pachynus* Stål, which is related to *Macropsis* occurs in South Africa, and that *Penthimia* and *Rubria* Stål are placed in the Gyponinae.

Baker (1923) presented a classification based on the fauna of the world, although he acknowledged that it did not presume to be a complete system since some of the most important anatomical features of several jassoid genera are neither described nor figured. He divided the Jassoidea into fifteen families, the Tettigonellidae (Cicadellidae), Gyponidae, Penthimiidae, Thaumatoscopidae, Ledridae, Paropiidae, Stenocotidae, Koebeliidae, Ulopidae, Signoretidae, Euacanthidae, Pythamidae, Nirvaniidae, Jassidae, and Bythoscopidae. Up to the present the author has accepted Baker's classification, although the Eupterygidae (Typhlocybidae) have been resognized as a distinct family, and following Haupt (1929), *Jassus* and related genera have been considered as a family, the Jassidae, distinct from the Euscelidae, which comprises the majority of genera usually placed in the Jassidae.

The Comparative Value of Different Morphological Characters.

The Jassoidea are defined by Imms (1925), who gives them family rank, as having 'Ocelli two, rarely absent, variable in position. Antennal flagellum composed of numerous joints. Genae dilated, the frons, lorae, and genae forming one curved surface. Pronotum never prolonged backwards. Posterier coxae transverse, laterally dilated; tibiae angular, the hind pair usually seriately bristly with a double row of spines; empodia large.' This definition, whilst serving to separate the group from the Membracidae and Cercopidae, is not entirely accurate, since, with many species the frons, lorae, and genae do not form one curved surface, and the hind tibiae may be circular in outline and have more than two rows of spines.

In order to determine the inter-relationships of the various genera and groups of genera, six structural features will be reviewed in turn, and the comparative value of each estimated. The selected characters are the venation of the wing; the venation of the tegmen; the shape and armature of the hind tibia; the structure of the male genitalia; the shape of the prothorax; and the external morphology of the head.

If these six characters in a number of genera are examined in order to decide upon their relative degree of stability, it is found that the venation of the wing is the one least subject to variation, and the next most stable characteristic is the venation of the tegmen. This is because venation is not subject to change following a re-orientation of muscle stresses, and the hind wing being used solely for flight purposes, will vary less than the tegmen, which has a protective as well as a flight function. Following venation, the next most persistent characters are to be found in the basic structure of the head, and of the several factors that have to be taken into account in surveying the morphology of the head, the position of the ocelli is the most unreliable, since it is the most subject to variation. It is convenient to follow a discussion of the head by an examination of the shape of the prothorax, particular attention being paid to the propleurae. Finally come the shape and armature of the hind tibia and the structure of the male genitalia, both of which supply evidence of minor importance since they are more subject to change. Whilst there are other characteristics that could be taken into account, such as the hind tarsi, which Baker (1923) believed to be of value for taxonomic purposes, those chosen are sufficient for the present purpose.

Wing Venation.

Comstock (1918) has pointed out that the Jassoidea resemble the Membracidae in that in the wings of neither group has a transverse basal trachea been developed, and the medial trachea is a member of the costo-radial group. This primitive condition occurs also with the Plecoptera and certain cockroaches.

The nomenclature followed is that of Metcalf (1913, 17), except in respect of the first anal vein for which Tillyard's (1926) interpretation is accepted, this vein being considered as the second cubital vein. Plate IV, fig. 7, represents the wing of *Putoniessa rivularis* (Walk.), of which the venation is typical of that occurring almost universally amongst the Jassoidea, Lying well away from the costal margin is a thickened vein, consisting of the apposed sub-costal and radial veins. R_1 is not developed and the radial sector is two-branched, the branches being R_{2+3} and R_{4+5}. The media is distinct basally, and not fused with the radius; distally it has two branches M_{1+2} and M_{3+4}. The remaining veins need no comment, except that the marginal vein is formed by the united tips of the longitudinal veins. Plate IV, fig. 5, represents the wing of *Eurymeloides punctata* Sign., in which the venation is identical with that of *P. rivularis*. Apart from the Eupterygidae a number of divergences from a typical wing occur, such as those shown in Plate IV, figs. 6 and 8. In figure 6, (*Bythoscopus lanio* L.) R_{4+5} and M_{1+2} are united apically. Such a condition occurs in the related genera *Eurinoscopus* Kirk. and *Trocnada* Walk. The wing of *Tartessus fulvus* (Walk.) (fig. 8) is unusual in that the marginal vein extends onto the anal area. This feature also occurs in the related genera *Sarpestus* Spangb., *Tartessoides* Ev. and *Tartessella* Ev.

The wings of the Eupterygidae, which have been figured by Ribaut, are of interest since, with certain genera (*Typhlocyba* Germ. and *Eupteryx* Curt.), a marginal vein is not developed to link the radius and second cubitus, although present, parallel with the hind margin of the wing. It is developed in other genera (*Dikraneura* Hardy). A tendency exists in representatives of this family for the veins to unite apically, so that the radius and media may terminate as a single vein (*Typhlocyba*), as two veins (*Eupteryx*), or as three (*Dikraneura*), but never as four, as is usual in the rest of the Jassoidea.

The notation used on Plate IV is not in accordance with that adopted by Ribaut, as his sub-costal is the radius, his radius the media, and his media the first cubital.

As the venation of the wing is a stable character, it might be supposed that a comparison of a typical jassoid wing with those of related groups would supply evidence of wider affinities.

Plate IV, fig. 3, represents the wing of *Sextius virescens* Fairm. (Membracidae), which is essentially identical with the normal jassoid type, the only difference being that the sub-costal vein is incorporated in the costal border and does not lie alongside the radius. The three remaining wings figured on Plate IV all show a wide divergence from the jassoid type, the closest being that of *Aethalion reticulatum* L. (fig. 4). In this wing Sc and R are distinct basally, the former being incorporated in the costal border, the radius terminates as a single vein, and the media is two-branched.

Fig. 2 represents the wing of *Cercopis jactator* F.B.W., in which, although the radius is two-branched, the media is a single vein, and is joined to the fused radial and sub-costal veins well anterior to the base of the wing. Extreme reduction is seen in fig. 1 (*Hindola compacta* Walk., Machaerotinae, Cercopidae), in which both the radius and media are unbranched, although the sub-costa is distinct basally. It is believed that the Machaerotinae are related to the Permain Scytinopteridae, since the tegminal venation of the two groups is similar.

It is thus apparent that but little light is thrown upon the relationships of the various jassoid families from a study of wing venation; this character, however, is of use in certain cases in assisting to link genera into minor groupings, where, although no changes have taken place in the basic venation of the wing, secondary vein fusions or reductions have occurred.

As far as wider relationships are concerned, the membracid type is similar to the jassoid, and that of the Aethalionidae, although distinct, displaying specialization by reduction, is nearer to the Jassoidea and the Membracidae than to either the Cercopinae or Machaerotinae.

Venation of the Tegmen.

The tegmina of several Homoptera have been found well preserved in Palaeozoic and Mesozoic strata, hence something is known of the venation of the ancestors of recent groups, but since the present-day representatives of this sub-order are mostly confined to a limited range of food-plants, it is not to be expected that they will have any great affinity to forms that may have lived on such plants as *Glossopteris*. The Angiosperms, on which most recent jassoids feed, did not develop until Triassic times, whilst those extinct species which are best known, largely from tegminal impressions, are from rocks of Permian age.

It has been previously mentioned that the Permian Scytinopteridae show affinities to present-day Machaerotinae. Tillyard (1926), however, considered that *Permojassus australis* Till., which he placed in the Scytinopteridae, might well, on tegminal venation alone, be placed in the Jassidae, its principal difference from recent forms being

that the media is three-branched and the costal space extensive. However, any idea of jassoid relationship is disposed of by the hind-wing, which has also been found.

Three Triassic tegmina have been ascribed to the Jassidae (Tillyard, 1920), *Eurymelidium australe* Till., *Mesojassus ipsviciensis* Till., and *Triassojassus proavitus* Till. As pointed out by Tillyard, the venation of *E. australe* somewhat resembles that of *Eurymela* Le P. and S.; the sub-costa is not apparent as a separate vein, the radius is unbranched, and the media has two branches, but a considerable development of cross veins occurs such as is not found in modern eurymelids, except in the costal region. In the development of the radius and the media, *Mesojassus* also resembles *Eurymela*, whilst *Triassojassus*, though having a media with three apical branches, has a radius similar to that of many present-day groups other than the Eurymelidae, its three branches apparently being R_1, R_{2+3}, and R_{4+5}.

Handlirsch (1908) figures a number of Jurassic tegmina, of which two, *Acocephalites breddini* Meunier and *Jassites punctatus* Brodie, resemble the majority of present-day groups in having a radius with two principal branches R_{2+3} and R_{4+5}, R_1 also being distinct in the latter, and with an unbranched media. Two other tegmina figured might well have belonged to primitive jassoids. These are *Homopterulum signoreti* Westwood and *Pseudodelphax pulcher* Brodie, in both of which R and M are two-branched.

Martynov (1926) has created two species, *Karrajassus crassinervus* and *Archijassus minimus* on Jurassic tegmina from Turkestan, which he placed in this family. The tegmen of the former shows relationships with *Triassojassus*, whilst *Archijassus* is only represented by a fragment.

On the scanty evidence available it would seem that true jassoids first appeared in Triassic times and are descendants of a Permian group, of which so far no representatives have come to light.

Carpenter (1933) gives a reconstruction of a hypothetical forewing of the common ancestor of Permian Homoptera. This figure is reproduced on Plate V, fig. 1, for comparison with the present author's reconstruction of the forewing of a hypothetical ancestor of recent jassoids. The principal difference between the two figures is concerned with the radius, as, although in both cases it is shown to have three branches, in fig. 1, R is two-branched and Rs single, and in fig. 2 R is single and Rs two-branched. The identification of the components of the radius in fossil impressions is made possible by the fact that R is convex and Rs concave.

According to Metcalf, the sub-costal trachea is anomalous, and may be very long, as in *Jassus*, or about half the length of the main stem, as in *Platymetopius* Burm. In only one genus, *Sarpestus* (Plate VI, fig. 8), has the sub-costal vein been noted as distinct

from the costal margin, and in some species in the related genus *Tartessus* Stål it is apparent in a reduced form. The radius retains its primitive condition in a number of genera, as shown on Plate VI, in all figures but 4, 6, and 10, with which R_1 is absent, the two branches representing R_{2+3} and R_{4+5}. With other genera, for example *Kyphoctis* Kirk. (Plate V, fig. 8), several costal veinlets may be present, and it is possible that one of these may represent R_1. In *Aethalion reticulatum* (Plate V, fig. 4), and with the Eurymelidae (Plate V, figs. 3, 5, 7, 9) R_{2+3} and R_{4+5} occur as a single vein, but R_1 may be distinct, as shown on Plate V, fig. 3, which represents the nymphal tegminal pad of *Eurymelops rubrovittata* A and S.

Metcalf, referring to the tracheation, states that the media is typically two-branched and that M_{1+2} must have come to lie parallel with R_{4+5} and become gradually reduced to its usual present condition of, at the most, only a cross vein connecting the media with R_{4+5}. In the fully developed tegmen the media occurs as a single vein, except with the *Eurymelidae*, in which it forks into two principal branches. In certain genera in this family the lower branch may re-divide into M_3 and M_4 (e.g., *Cornutipo* Ev., Plate V, fig. 7), whilst with others all four branches may be distinct, as is shown in the figure of the tegmen of *Pogonoscopus lenis* (Jac.) given by China (1926). The first cubitus is almost invariably two-branched, but, as shown in Plate V, fig. 8 *(Kyphoctis)* and fig. 4 *(Aethalion)*, secondary veinlets may be developed at its apex. The second cubitus lies along or close to the claval suture and connects with the margin of the tegmen. The only departure from the normal that occurs in the anal area is that a Y-vein may be formed. This probably originates in a cross-vein first connecting the two anal veins, followed by the second anal vein terminating at the cross-vein instead of extending to the anal border. Such a Y-vein is found in all the Australian Stenocotidae and in a number of genera in other families. It is also present in all the Fulgoroidea, and occurred in the Mesozoic Ipsviciidae.

Plate V, fig. 6, represents the tegmen of *Paradorydium menalus* Kirk., in which the radius appears to be a single vein, and the media seems to have two branches. Actually the reverse position occurs, the elongation of the tegmen having drawn out the cross-vein that represents all that is left of M_{1+2}.

Plate V, fig. 10, represents the tegmen of *Idiocerus seckeri* Ev., which is similar to all other Australian species that have been placed in this genus, but differs from European representatives, which have normal complete venation as far as the radius is concerned.

On major differences in the venation of the tegmen the Jassoidea can be separated into three distinct groups, the Aethalionidae, in which both the radius and the media are unbranched; the Eurymelidae, in which R_{2+3} and R_{4+5} are represented by a single vein,

and the media always has two principal, and may have three or four subsidiary, branches; and the rest of the Jassoidea, in which the radius has at least two branches, and the media is either unbranched or has one branch reduced to a cross-vein. Apart from the presence or absence of R_1, the development of cross veins, the extent of the appendix and the partial fusion of adjacent veins, the venation of the tegmina of the third group of the Jassoidea, is remarkably uniform. Such differences as do occur are only of use when considered in conjunction with other characters for separating minor groups.

The Head.

It is quite certain that the most reliable criteria for the determination of the inter-relationships between various jassoid groups are to be obtained from a study of head structure. This has, to a certain extent, been recognized in the past, since the usual divisions of the Jassoidea into families and sub-families have been based upon a cephalic character, the position of the ocelli. The choice of this character is an unfortunate one as it is unreliable, hence genera which are clearly related on other grounds may have species in which the ocelli are ventral, marginal, or dorsal. On the other hand, genera that have no other common characteristic have been placed in the same family merely because of the similar position of the ocelli.

The forerunners of present-day leaf-hoppers probably had opisthognathous heads with two distinct median sclerites, the clypeus, and the frons. The hind margin of the frons lay well away from the hind margin of the head, and the paired ocelli were situated close to the posterior corners of the frons. The dilator muscles of the sucking-pump were attached to the posterior half of the clypeus, which was wider than the anterior half. The sutures that bounded these sclerites, and which have been discussed in an earlier paper (Evans, 1938), were the clypeal suture, that extended from the point where the two divisions of the clypeus met, and terminated close to the antennae; the frontal suture that lay between each antenna and the ocellus, and the Y-shaped epicranial suture that lay along the posterior margin of the frons. Separating the clypeus from the frons was the transverse epistomal suture, and dividing the vertex, which must have been entirely ventral in position, was the coronal suture. A sub-genal suture was also present. Changes from such a type have taken place in several directions, the first, and almost universal change being the fusion of the frons and the clypeus and the disappearance of the epistomal suture. This was brought about by the gradual backward migration of the dilator muscles of the sucking-pump. Accompanying the disappearance of the epistomal suture the development of a transverse suture took place, separating the clypeus into two parts, an ante- and post-clypeus. This suture connects the apices of the clypeal sutures.

In certain groups, not only has the epistomal suture been obliterated, but no trace remains of an epicranial suture. This backward development of the fronto-clypeus has been accompanied by a shifting of the ocelli, which thus came to lie at the margin of the head. In other groups the head is now in two or even three planes, and, in some, the posterior third or less of the fronto-clypeus has become dorsal in position, forming with the vertex the crown of the head.

The ocelli have moved onto the crown of the head in three distinct ways. In some cases they have retained their position close to the junction of the frontal and epicranial sutures and the flexing of the head has changed their aspect (Penthimiinae). In others, although the epicranial suture remains ventral, they have migrated to a marginal, and finally a dorsal, position by way of the anterior apex of the head (Ulopidae, Stenocotidae), whilst in others, in which the head has become greatly produced and flattened and no traces remain of the epicranial sutures, the ocelli have moved from their position at the apices of the frontal sutures to the edge of the head close in front of the eyes, and from thence on to the crown (Ledridae).

The shifting of the ocelli in the last two instances cannot have been brought about by changes in muscle stresses, but must be a direct response to light stimuli. Kennedy (1928) has pointed out that the majority of primitive living insects occupy environments of low intensity of light and heat, and that Mesozoic climates may have had a general lower level of intensity, so that changes in the position of the ocelli from a ventral to a dorsal aspect may have been a reaction to a change of environmental conditions.

Such changes from a hypothetical primitive head as have been described have taken place independently in several distinct groups. To illustrate this, attention is drawn to the illustrations on Plates VII, VIII, and IX; only numbers will be referred to, names for the time being ignored. On Plate VII, fig. 7, is shown the head most nearly approaching the supposed archetype, since a trace of an epistomal suture remains. In the nymph of this particular species, the suture is complete. Figs. 5 and 6, on Plate VIII, display the same feature, whilst Figs. 6, 8, 9, 10, and 11 (Plate VII) represent the next step, in which, although the epistomal suture is obliterated, the ocelli and the greater part of the vertex remain ventral in position. Figs. 1 and 3 on Plate VIII are of special interest, in that, although the epistomal suture is lost, traces remain of the subgenal suture.

How the ocelli may become dorsal, though remaining close to the epicranial suture, is shown on Plate VII, figs. 2 and 4, which illustrate species in related genera. Plate IX, fig. 13, is another instance. Steps in the movement of the ocelli from the underside to the top of the head, occurring both laterally and apically, are shown on Plate VIII, fig. 5, Plate IX, figs. 3, 4, 5, 11, and 12. Not only may

all trace of the epistomal, coronal, and epicranial sutures be obliterated, but the frontal sutures may also disappear (Plate VIII, figs. 3, 4, and 7). Further discussion of the lines of development of leafhopper heads will be given in later sections. In order to make full use of head-shape and structure as a basis for phylogeny, a long series of forms must be studied before arriving at an estimate of the stability or otherwise of the various characters.

The Prothorax.

A study of the prothorax is helpful, as it supplies valuable supporting evidence for use with other characters. On Plate IX the prothoraces of a number of species are figured in lateral aspect, and the principal point to be noted, and to which attention will be drawn later, is the width of the segment at the point of junction of the pronotum and propleurae. The episternum is seldom visible, being reduced and hidden by the head, but the epimeron (shaded in all figures) is seen to be wide dorsally in most of the figures, and narrow in only a few, and in only one case (fig. 10) is its dorsal ending hidden. The pronotum likewise may be wide laterally or very narrow.

Hind Tibia.

Whilst the venation of the wings and tegmina are of greatest value in determining the limits of the principal jassoid groups, and the head supplies the most reliable characters for the separation of lesser groups, the hind tibiae are of subsidiary value. In the possession of elongated hind tibiae, armed with three or four rows of spines, the Jassoidea differ markedly from the Cercopidae, which have short, apically thickened hind tibiae armed with one or two stout spurs, and differ, though to a less marked extent, from the Membracidae, which have short hind tibiae, semi-circular in outline, that are covered with hairs, and may also have one or two rows of very small spines.

A number of types of tibial armature are illustrated on Plate X. The various figures will be referred to in connexion with the different families. It is supposed that the ancestors of present-day jassoids had hind tibiae that bore a row of long hair-like spines on one edge, two rows of evenly spaced spines arising direct from the tibia itself, and a row of spines mounted on prominent bases, that may have either decreased in size from the apex to the base, or have been of equal size. Such types are shown in figs. 1, 3, 4, 9, and 12. Changes have occurred in the elongation of the tibia, accompanied by a wider separation of the spines (figs. 8 and 11), the reduction in size and even disappearance of most of the spines and the increased development of one or a few spurs (figs. 5, 14, and 15), and in the reduction in size of the spurs and the addition of minute spines set between their bases (figs. 7 and 13). Of the four figures so far

not mentioned, figs. 2 and 16 represent slight deviations from the supposed primitive type, whilst fig. 10 is the hind tibia of *Aethalion reticulatum*, which has more membracid than jassoid affinities, and fig. 6 represents the hind tibia of *Lasioscopus acmaeops* (Jac.), which, being a myrmecophile, has certain adaptive characters.

Male Genitalia.

For a long time the male genitalia have been a favourite character for use in specific determinations, and there is no doubt that their structure is of value for this purpose. The mere fact that they are usually the first part of an insect's body to show any morphological changes following species differentiation, would suggest that they are peculiarly unstable, and therefore likely to be of little use for the determination of the relationships of major groups. With certain reservations, this is held to be the case, yet Singh-Pruthi (1925), in his valuable work on the male genitalia of Hemiptera finds sufficient characters in these organs alone to suggest certain basic jassoid relationships.

The male genitalia of the Jassoidea are situated on the ninth, tenth, and eleventh abdominal segments. The ninth segment is very wide in the tergal region and narrow in the sternal region, and bears a pair of appendages, the sub-genital plates, or, as Snodgrass (1935) terms them, the harpagones. The aedeagus projects from the segmental membrane, which is a backward continuation of the body wall that separates the ninth from the tenth sternite, and may have a large basal apodeme for muscle attachment. It is usually attached to a phallobase, the basal plates of Singh-Pruthi, to which are connected accessory clasping organs, the parameres. With many genera the ninth segment extends posteriorly past the segmental membrane as a pair of protective flaps, the pygophores. In addition to the processes mentioned above, a pair of styles may be developed, either on the sub-genital plates or on the pygophores. The tenth segment is much reduced, and beyond it again is a still smaller sclerite, and the anal style. Following Singh-Pruthi, the sclerite between the tenth segment and the anal style is regarded as the greatly reduced eleventh segment.

On Plate XI are figured the male genitalia of twelve species of leaf-hoppers. Figs. 1 and 2, which represent the genitalia of *Bakericla procurrens* (Jac.) and *Eurymela fenestrata* Le P. and S. respectively, differ from all the others in lacking any development of a pygophore, but the most noteworthy difference is that the phallobase or basal plates of these species, both of which belong to the Eurymelidae, have no connexion with the aedeagus. Wide apodemal processes serve instead for the attachment of the muscles that control the aedeagus, which is directed ventrally; this is universal

throughout the family. Whilst the sub-genital plates of *E. fenestrata* are wide, and bear strong styles that arise from their ventral margins, those of *B. procurrens* are narrow and do not carry styles. The lack of styles is a character common to all species in the subfamily Ipoinae, but they are universally present with the Pogonoscopinae and Eurymelinae, but in one genus in the last mentioned family (*Eurymelita* Ev.) they arise from the dorsal and not the ventral margin of the sub-genital plates.

The genitalia of *Idiocerus kirkaldyi* Ev. (Plate XI, fig. 6) are of interest, because the basal plates, which are fused into a Y-shaped structure, are produced as a thecal sheath that invest the aedeagus, except at the distal end, resulting in the wide separation of the aedeagus from the basal plates proper. This suggests an approach to a condition such as is found in the Eurymelidae. Each side of the base of the exposed portion of the aedeagus is covered by the ends of narrow pleural plates that belong to the tenth segment. A somewhat similar structure is seen in fig. 4 (*Macropsis tasmaniensis* Ev.), but with this species a style is developed, and a process attached to the basal support of the aedeagus.

With *Eurinoscopus viridis* Ev. (Plate XI, fig. 3), although, as with *I. kirkaldyi*, the aedeagus base is at some distance from the parameres, the intervening space, in this instance, is bridged by the basal plates themselves. Fig. 5 (*Austroagallia torrida* Ev.) differs from the other genitalia illustrated in that the ninth segment is wide ventrally, but this is of no significance as species in related genera, figured by Lawson (1920), have the usual narrow ventral development of this segment.

Singh-Pruthi considers that the genitalia of the various groups can be *roughly* reduced to three sub-types, typically found in the Bythoscopinae, Jassinae, and Tettigoniellinae, also that the Jassine type is the central from which the other two can be derived. The genitalia of five other sub-families recognized by this author are considered by him to show a medley of relationships, as, for instance, the Megophthalminae (Paropiidae) essentially resemble the Bythoscopinae, but have sub-genital and basal plates of the Jassine type, and the Ledrinae possess characters of both the Tettigoniellinae and Bythoscopinae!

It is apparent that, whereas the male genitalia are of great value for specific differentiation; for determining the limits of a genus; and the degree of relationship between allied genera, with certain exceptions, they are of little help in deciding the affinities of major groups, except as subsidiary characters taken in conjunction with others of more dependable nature. As an example of the unreliability of deductions based on genitalia alone, attention is drawn to

Plate XI, figs. 1, 3, and 4, which represent the genitalia of three species of leaf-hoppers, all of which were formerly placed in the Bythoscopidae, and which might be supposed to be related on grounds other than the position of the ocelli, since all have long, narrow subgenital plates. The genitalia of *B. procurrens* (fig. 1) have already been shown to differ radically from all those figured, with the exception of *E. fenestrata* (fig. 2), even though superficial examination would not suggest affinity between these two species. Fig. 6 (*I. kirkaldyi*), also formerly placed in the Bythoscopidae, has only superficial resemblance to fig. 3, whilst fig. 5 (*Austroagallia torrida*), though previously classed in the Bythoscopidae, has no resemblance at all to either fig. 3 or 4.

Proposed Classification.

In a previous paper (Evans, 1936) the statement was made that it was unfortunate that the Palaearctic jassoid fauna was the first to be studied thoroughly, since the classification of other faunas has of necessity been based on this, and that it was believed that, when the Australian fauna was better known, new light would be shed on the whole jassoid complex.

In the system now presented the Jassoidea are divided into twenty-one families, a number of which are of doubtful status. In establishing this system of classification, due regard has been paid not only to morphological details, but also to general appearance, sculpturing, and coloration. In no case has a single characteristic, such as the position of the occelli, been allowed to assume undue importance.

After considerable thought it was decided to give each of the major divisions the rank of Family, as by so doing the arrangement of the lesser groups is facilitated. It is certain that the Aethalionidae and Eurymelidae are worthy of separation almost as complete as that of the Membracidae, but for convenience they are classed as ordinary jassoid families. Certain of the more recent families, such as the Euscelidae and Eupterygidae, which are represented by numerous genera and species, are not as distinct as others, such as the Paropiidae and Austroagalloididae, which are only represented by a few survivors from an earlier geological age. Families, such as the Euacanthidae are retained only provisionally because the author is familiar with but a few representatives, and hence is not in a position to determine their true status. The accounts of the various families are not intended as definitions, as such would be impossible without a full knowledge of the fauna of the world, and only brief mention is made of well-known established families for which no changes are proposed.

Aethalionidae

(Plate IV, fig. 4; Plate V, fig. 4; Plate VII, fig. 9; Plate X, fig. 10)

This family is confined to South America. Only one species, *Aethalion reticulatum* L., is known to me. Baker (1915) suggested that relationships might exist between this family and the Eurymelidae, but there is no resemblance between the two groups in a single character of any significance.

They have already been shown to differ from the rest of the Jassoidea in the venation of both the wing and the tegmen, and in the armature and shape of the hind tibia. The adult head displays several primitive characteristics, such as the ventral position of the ocelli and the persistence of the coronal and epicranial sutures. In the nymphs there is no suture separating the ante-clypeus from the fronto-clypeus, but an ill-defined epistomal suture occurs, traces of which may be seen in the adult head. Other features that serve to separate the Aethalionidae from the rest of the Jassoidea are the proximal fusion of the sub-genital plates and the large pronotum. Mr. China has informed me that species in this family are ant-attended, thus resembling the Membracidae in habits as well as in certain structural details.

Eurymelidae

(Plate IV, fig. 5; Plate V, figs. 3, 5, 7, 9; Plate VII, fig. 8; Plate X, figs. 4, 5; Plate XI, figs. 1, 2)

The Eurymelidae, which are the dominant family of leaf-hoppers in Australia, have two outstanding characters that separate them from the rest of the Jassoidea. The media of the tegmen has two, three, or four branches, and the aedeagus is completely separated from the basal plates. Apart from these features their appearance is distinct, and they can be recognized by their flattened face and more or less diamond-shaped fronto-clypeus, which is completely surrounded by well-defined sutures. The ocelli are always close to the junction of the frontal and epicranial sutures, well away from the posterior border of the head, and show no tendency to migrate to a marginal position. There are three distinct sub-families, the Ipoinae, Pogonoscopinae, and Eurymelinae. It is believed that the Ipoinae are the most primitive and that the Pogonoscopinae are a specialized off-shoot from the base of the Eurymeline stem.

The Ipoinae, of which thirteen genera, containing twenty-nine species, have so far been described (many more await description), feed principally on eucalyptus trees, but two species have been recorded from *Casuarina* sp., one from *Eremocitrus glauca*, and others occur on mistletoe *(Loranthus)* growing on various hosts. They range from small forms with narrow sub-genital plates to large species with wide sub-genital plates. Two species are of special

interest; one of these, *Bakeriola procurrens*, which is confined to Western Australia, has hind tibiae with a complete armature of spines, whilst most eurymelids have a reduced armature, accompanied by spur development. The sub-genital plates are simple, being long and narrow without accessory styles; the tegmina are not tectiform, and the head facially is as wide as long. None of these characteristics are typical of the family, and suggest that *B. procurrens* is a generalized species, and may represent a type from which other forms have arisen. The other species of interest is *Cornutipoides tricornis* Ev., also from Western Australia (figured in Evans, 1934), which has a prominent horn on the head formed entirely of the fronto-clypeus, and a pair of lateral horns arising from the vertex on each side. It differs from other described members of the family in having narrow maxillary plates and prominent globular eyes, and, as with the related *Cornutipo scalpellum* Ev., the media in the tegmen has three branches. It is assumed that, whilst the venational character is primitive, the others mentioned are due to extreme specialization.

The Eurymelinae, of which twenty-five species, contained in seven genera, have been described, range from forms very similar to the less specialized Ipoinae to large, brightly coloured species that have reduced tibial armature and large sub-genital plates.

The Pogonoscopinae, which are largely confined to Western Australia, and of which six species, contained in three genera, have been recorded, are all myrmecophilous and feed on the roots of eucalyptus trees.

Until raised to family rank by the present author in 1934, the Eurymelidae were included in the Bythoscopidae solely on account of the facial position of the ocelli. Singh-Pruthi suggested that, in the reduction of the basal plates and in the flap-like sub-genital plates, the group approached the Cercopidae, but a consideration of other characters lends no support to this view. Although now widespread in Australia and extending to New Guinea and New Caledonia, it is probable that this family developed in Western Australia in Cretaceous times, when that part of the present continent was separated from Eastern Australia by a wide sea (Tillyard, 1924). Their close association with trees of the genus *Eucalyptus* lends support to this view, since there is evidence to show that these trees date back to Cretaceous times (Seward, 1931). Though descended from an ancient stock, the wide variation in coloration and minor structural features that occurs in many genera, suggests that species differentiation is still in progress. Like the Membracidae and Aethalionidae, all the Eurymelidae are ant-attended, and in common with these groups the nymphs lack jumping powers, such as are common to all the rest of the Jassoidea.

Bythoscopidae

(Plate IV, fig. 6; Plate VI, fig. 6; Plate VII, figs. 1-4; Plate VIII, 7, 8; Plate X, fig. 1; Plate XI, fig. 3)

In an earlier paper (Evans, 1936), it was pointed out that the Bythoscopidae appear to comprise a heterogeneous collection of genera bound together by a single character of doubtful phylogenetic significance, the ventral position of the ocelli, and, in the paper referred to, the following Australian genera were placed in this family: *Eurinoscopus* Kirk., *Trocnada* Walk., *Chinaella* Ev., *Idiocerus* Lewis, *Pedioscopus* Kirk., *Austroagallia* Ev., *Austroagalloides* Ev., *Oncopsis* Burm., *Macropsis* Lewis, and *Stenoscopus* Ev..

With the exception of *Eurinoscopus, Trocnada,* and *Chinaella* it is now proposed to remove the above genera from the family and to add the following genera: *Penthimia* Germ., *Vulturnus* Kirk., *Neovulturnus* Ev., *Thaumatoscopus* Kirk, *Hecalus* Stål, *Reuteriella* Sign., and a genus not represented in Australia, *Gypona* Germ.. Only one point has received consideration in making these changes; whether or not the species in the various genera give evidence of phylogenetic affinities to *Bythoscopus* Germ.. It is realised that certain genera not represented in Australia should also be removed and others added, but those mentioned are sufficient for the present purpose. The reasons for discarding seven genera will be discussed in connexion with the families to which they have been relegated, but the first step is to explain why seven genera, none of which have previously been considered as having affinities to *Bythoscopus*, are placed in this family, and why three Australian genera have been retained in it.

Bythoscopus and Eurinoscopus

There has never been any doubt concerning the close relationships of these two genera, which differ solely in that the tegmen of *Eurinoscopus* is somewhat narrower than that of *Bythoscopus* and lacks the numerous costal cells present in the latter. Also species in the Australian genus are smaller and narrower than *B. lanio* L..

Eurinoscopus

As this genus, together with *Bythoscopus*, represents a basic type, the principal features are described. The head is much wider than long, has wide maxillary plates, a fronto-clypeus separated from the vertex by a perceptible though faint semi-circular suture, and prominent antennal ledges that extend from the eyes to the fronto-clypeus. The head (Plate IX, fig. 1) is neither evenly convex nor flat, and that part anterior to the antennal ledges lies at an angle to the rest. The tegmina overlap apically, and the area enclosed by the two branches of the first cubitus is not pigmented as is the rest

of the tegmen, but forms a supplementary appendix. The wing (Plate IV, fig. 6) has the apices of R_{4+5} and M_{1+2} fused into a single vein, and the hind tibiae (Plate X, fig. 1) are flattened and slightly curved and bear an armature of regular spines, and when the insect is at rest the hind femora, which bear apical spines, lie against the wide propleurae.

Eurinoscopus and Chinaella

Chinaella (figured in Evans, 1936) differs from *Eurinoscopus* in the more declivous head and pronotum and the greater overlap of the tegmina apically.

Eurinoscopus and Trocnada

Trocnada resembles *Eurinoscopus* in all essential cephalic characters, but differs from it in that posterior to the antennal ledges the head is on a plane with the declivous pronotum and at right-angles to the anterior half of the head. Species in the two genera are similar in the venation of the tegmen, the possession of a supplementary appendix, the venation of the wing, the shape and armature of the hind tibiae, and in the structure of the male genitalia.

Eurinoscopus, Trocnada, and Penthimia

The close resemblance between the heads of insects in these three genera may be seen by a glance at Plates VII and IX. On Plate VII, figs. 1 and 2 and 3 and 4 represent the heads of *Penthimia americana* Fh. and *Trocnada gigantea* Ev. respectively, and on Plate IX, fig. 1, represents the head of *Eurinoscopus viridis* in profile, and fig. 2, *Penthimia americana* in the same aspect. The figures make discussion unnecessary, and all that need be mentioned is that in essential points of structure there is no difference between the three heads. Species in all three genera have the prothorax similar in shape, and the position of the hind femora and the shape and armature of the hind tibiae are identical. The tegmen of *Penthimia* approaches that of *Bythoscopus* more than *Eurinoscopus*, and the wing venation is of the normal jassoid type.

Eurinoscopus, Penthimia, Neovulturnus, Vulturnus and Thaumatoscopus

All the above genera, except the first, have been previously placed in the Penthimiidae (Evans, 1937, c), and their inter-relationships discussed. In the paper referred to, figures were given to show progressive change in head-shape from a species resembling *Eurinoscopus* (*Neovulturnus lapsus* Ev.) to one resembling *Penthimia* (*Neovulturnus maculosus* Ev.), and from such a type to a species with a produced foliaceous head (*Thaumatoscopus dunkensis* Ev.).

Neovulturnus, *Vulturnus*, and *Thaumatoscopus* resemble *Eurinoscopus* in having overlapping tegmina with supplementary appendices, wide propleurae, and hind femora that rest against the propleurae, and hind tibiae similar in shape and armature.

Eurinoscopus and Reuteriella

The head of *R. flavescens* (Plate VIII, fig. 7; Plate IX, fix. 3) differs from those of species in the genus *Eurinoscopus* in being considerably produced and flattened, and in lacking frontal and epicranial sutures, but resembles it in the shape of the maxillary plates and in having distinct antennal ledges that extend as far as the eyes. The pronotum is wide laterally and on a plane with the crown of the head, and the propleurae widely separate the eyes from the base of the tegmina. The latter are long and narrow, and have a supplementary appendix, and the wings have R_{4+5} fused apically with M_{1+2}. *Reuteriella* also resembles *Eurinoscopus* in characters supplied by the hind legs.

Reuteriella and Gypona

Gypona (Plate VIII, fig. 8 and Plate IX, fig. 5) differs from *Reuteriella* in having the ocelli on the crown of the head and not marginal, and in having a less produced head. However, in *Reuteriella*, the ocelli, though usually marginal, may be on the crown close to the margin, but not touching it. In both genera the coronal suture is distinct on the crown, but in neither does it extend to the apex, suggesting that the crown consists in part of the fronto-clypeus, so that the division of the head into dorsal and ventral surfaces may have started as in *Trocnada* and *Penthimia* and have been followed by a flattening process, as in *Thaumatoscopus*. The prothorax of *Reuteriella* is similar in shape to that of *Gypona*; the tegmina of both are long and narrow, but those of *Gypona*, although they overlap apically, lack a supplementary appendix, and in the wing of *Gypona*, although R_{4+5} is distinct from M_{1+2}, there is no cross-vein between them, and the veins touch at the point usually occupied by a cross-vein. The hind legs of *Gypona* are similar in shape and armature to those of *Reuteriella*, but the hind tibiae may have a few minute spines set between each of the largest spines.

Hecalus

Hecalus (Plate IX, fig. 4) must also be placed in the Bythoscopidae, although the head differs from those already described in lacking prominent antennal ridges, and in having a swollen fronto-clypeus.

The ocelli are on the margin of the head just in front of the eyes close to the apices of the frontal sutures. Epicranial sutures are absent, but the coronal suture is distinct and from its shortness it is evident that the greater part of the crown is of fronto-clypeal origin. The tegmina are short, do not overlap, and may be brachypterous in one sex. The wings have normal venation. Thus, although in certain characters this genus displays no obvious relationship with *Eurinoscopus* and other genera in the *Bythoscopidae*, it resembles them in the basic structure of the head, in the shape of the prothorax, and in the shape and armature of the hind tibiae.

It is not suggested that the genera placed in this family are all very closely related to one another, but it is maintained that they all have greater affinity to *Bythoscopus* than have such genera as *Agallia* and *Macropsis*, and than they themselves have to other genera, such as *Euscelis* and *Thamnotettix*. The family may be divided into three sub-families, the Bythoscopinae, Penthimiinae, and Gyponinae, the Penthimiinae being subdivided into the Penthiminii and Thaumatoscopini, and the Gyponinae into the Gyponini and Hecalini.

Euscelidae

(Plate VIII, fig. 10)

The Jassinae have presented in the past a bewildering collection of genera of doubtful affinities, linked together by the fact that all have the ocelli on the margin of the head. As understood here, this family includes only such genera as *Thamnotettix* Zett., *Chlorotettix* Van D., and *Selenocephalus* Germ, which are all related to *Euscelis* Brullé.

The Euscelidae are poorly represented in Australia, and no attempt is made to remove all the genera which have been placed in the Jassinae in the past, and which do not belong to the Euscelidae, although a number are changed to other families, and for certain groups of genera, new families are erected.

There is little doubt that the Euscelidae are not far removed from the Bythoscopidae, but are of more recent development. With the head, the frontal sutures diverge outwards, the eyes and the ocelli lie at their apices on the margin of the head or just above or below it. A distinct epicranial suture is never developed, but the coronal suture is almost invariably present, and the crown of the head consists in part of the fronto-clypeus and in part of the vertex. The propleurae may be wide or narrow, and usually separate the eyes from the bases of the tegmina, and the hind tibiae are

heavily armed, but lack prominent spurs. No Acucephalini have been recorded from Australia. Lawson (1920), in defining this tribe, states that the ocelli are on the margin of the vertex or just above it, but much farther from the eyes than with the Jassini. Of the two species of this tribe available to me for study, *Acucephalus nervosus* (Schrank) and *Acucephalus fasciatus* L., the former is noteworthy in that the fronto-clypeus is confined entirely to the ventral surface of the head, and the flattened produced crown consists only of the vertex. Both species lack a marginal vein in the wing between R_{1+2} and Cu_1.

In so far as is known none of the Euscelidae are arboreal, but feed on low-growing plants, principally grasses.

Agalliidae.

(Plate VII, fig. 11; Plate XI, fig. 5)

This family, which comprises *Agallia* Curt., *Aceratagallia* Kirk., *Austroagallia* Ev., and related genera, contains a number of small insignificant species with certain distinctive cephalic characters, which serve to separate them from the rest of the Jassoidea.

The clypeal suture forms a continuous line with the antennal ledges on each side of the head, and the epicranial sutures, which are usually perceptible, though never well-marked, proceed from above the antennal ledges and are joined by the coronal suture. There is no trace of frontal sutures, and hence the ocelli, which in most leafhoppers lie at the apices of the frontal sutures, are isolated. In the Idioceridae, which somewhat resemble the Agalliidae in superficial characters, frontal sutures are distinct, and epicranial sutures, when perceptible, occur as a transverse suture that joins the apices of the frontal sutures. The pronotum narrows laterally, the bases of the tegmina lying close behind the eyes; both tegmina and wings have normal complete venation, and the hind tibiae, which have numerous spines, lack prominent spurs.

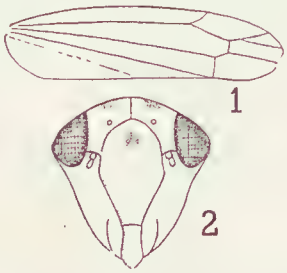
All known species feed on grasses and other low-growing plants, none being arboreal.

Eupterygidae

(Plate VIII, fig. 12)

The Eupterygidae are usually considered as a distinct family or as a tribe of the Jassinae. The majority of species have a head such as shown on Plate VIII, fig. 12 *(Typhlocyba ulmi)*, which resembles *Euscelis*, in that the frontal sutures diverge towards the eyes, and there is no trace of an epicranial suture, but others have

the frontal, epicranial, and coronal sutures distinct, which suggests that this family may have arisen from the same main stem as the Bythoscopidae independently of the Euscelidae. No named specimens with this character being available, recourse has been made to describing a new species of the genus *Empoasca* Walsh.



1. Tegmen of *Empoasca bancrofti.*
2. Head of *Empoasca bancrofti.*

Empoasca bancrofti, n. sp.

Length, 4 mm. *Head,* bright yellow with three large round black spots; eyes, black. *Pronotum,* yellowish-grey, medially black. *Scutellum,* yellow, lateral angles black. *Tegmen,* greyish-yellow. The rest of the body yellow. *Male Genitalia,* with the sub-genital plates broad basally and narrow apically and with short twisted parameres.

Type ♂, from Eidsvold, Queensland (coll. T. Bancroft), in the collection of the C.S.I.R. Division of Entomology at Canberra.

Idioceridae

(Plate V, fig. 10; Plate VII, fig. 12; Plate IX, fig. 8; Plate X, fig. 2; Plate XI, fig. 6)

This family is erected to contain leaf-hoppers in the genus *Idiocerus* Lewis and *Pedioscopus* Kirk., and in such other genera as are related to *Idiocerus,* but lack Australian representatives.

No attempt is made to define the limits of this family, but it will be shown that not only do species in the above genera give no evidence of close affinity with *Bythoscopus,* but also are they distinct from all other jassoid families. It is possible that Australian species that have been placed in the genus *Idiocerus* are not congeneric with the genotype, *I. adustus* H., but they are closely allied to it.

The head is flat or convex, but always in one plane, the crown, which consists solely of the vertex, never being sharply separated from the face. The antennal ledges are not prominent, and the

antennae of the males may have disc-like swellings near the tip. The frontal sutures are distinct and the ocelli lie at their apices, and coronal and epicranial sutures, which are seldom clearly defined, lie as shown on Plate VII, fig. 12. The propleurae are narrow, and the bases of the tegmina lie close behind the eyes. The tegmina, which are long and narrow and usually hyaline, have wide appendices, and the venation may be reduced. Those species representative of the Palaearctic fauna figured by Melichar (1890), have R^{2+3} and R_{4+5} present as distinct veins, but all described Australian species have these veins partially fused (Plate V, fig. 10), whilst, with *Pedioscopus*, although the radius is reduced, the media is distinct from it basally.

The venation of the wing is of the usual type, and the slender hind tibiae have a few prominent spurs that decrease in size from the apex to the base. The male genitalia, which are of an unusual type, have already been discussed. So far as is known all species in this family are arboreal.

Austroagalloididae

(Plate VI, fig. 4; Plate VII, fig. 5; Plate IX, fig. 10)

In 1936 (Evans, 1936) a new genus *Austroagalloides* Ev. was defined to contain a number of leaf-hoppers that had ventral ocelli, superficially resembled species in the genus *Idiocerus*, and which were thought to be related to *Agallia*. Further analysis of their structure has led to the decision that insects in this genus are sufficiently distinct to merit separation as a family, and it is probable that the present genus, which contains seven described species, should be divided into two or three genera.

The head (Plate VII, fig. 5) in most species lies in three distinct planes, and consists of a wide crown which is entirely made up of the vertex, and which is separated from the rest of the head by a transverse ridge, followed at right-angles by a more or less rectangular area bounded by the eyes laterally and the antennal ledges anteriorly. The only sutures present in this area are the frontal sutures that terminate close to the ocelli. The anterior portion of the head is more or less parallel to the crown. The figure of the head should be compared with those immediately above it on Plate VII, both of the upper figures being representatives of the Bythoscopidae, and the following differences noted. The eyes of *Austroagalloides nigra* Ev. are considerably larger and no sutures are developed above the apices of the frontal sutures, and, whilst the ocelli of both *Penthimia americana* and *Trocnada gigantea* lie on

the crown of the head close to the junction of the epicranial and frontal sutures, the crown of *A. nigra*, which is not shown in the figure, consists, as has already been mentioned, of the vertex only.

The pronotum (Plate IX, fig. 10) narrows laterally, and the bases of the tegmina lie close behind the eyes. The tegmina are long, narrow, and steeply tectiform, and have a very narrow appendix or none at all, and with the wings R_{2+3} is incorporated in the costal margin and not distinct. The hind tibiae have an armature of weak spines, either evenly spaced or reduced in numbers, and of the types figured resemble most closely Plate X, fig. 16. When the insect is at rest the proximal ends do not lie as far forward as the propleurae.

The family is confined to Australia, and all species feed on eucalyptus trees. Its representatives are especially abundant at altitudes over 3000 feet, although they also occur in areas subject to high temperatures and low rainfall.

Thymbridae

(Plate IV, fig. 7; Plate VII, fig. 10; Plate IX, fig. 7; Plate X, figs. 8 and 12)

The following genera, all of which are confined to Australia, New Guinea, and the neighbouring islands, are placed in this family, which was formerly considered (Evans, 1937, b) as a tribe of the Euscelidae: *Thymbris* Kirk., *Alseis* Kirk., *Epipsychidion* Kirk., *Putoniessa* Kirk., *Macroceps* Sign., *Rhotidoides* Ev., *Hackeriana* Ev., *Rhotidus* Stål.

In the more primitive genera, e.g., *Macroceps* (Plate VII, fig. 10), the head is much wider than it is long and the fronto-clypeus is small and entirely ventral. Posterior to the epicranial suture, but anterior to the ocelli, is a transverse ridge that extends right across the head to the eyes on each side. In genera, such as *Putoniessa* and *Rhotidoides*, with the backward extension of the fronto-clypeus, the ridge lies along the ventral apical border of the head, and the ocelli have moved from a ventral to a marginal position. In *Thymbris* the ridge is still perceptible, but the ocelli are on the crown, whilst in *Rhotidus* and *Hackeriana*, in which the head is produced and the ocelli on the crown, in the case of the former, well away from the apex; no trace remains of a transverse ridge or of the epicranial suture. Both the tegmina and the wings have normal venation; the pronotum is narrow laterally, and the hind tibiae are armed with prominent spurs that decrease in size from the apex to the base.

All known species are arboreal, and the majority are confined to eucalyptus trees.

Macropsidae

(Plate VI, fig. 7; Plate VII, fig. 6; Plate IX, fig. 6; Plate X, fig. 3; Plate XI, fig. 4)

It is difficult to understand why this well-distributed group of leafhoppers has been associated so long with *Bythoscopus*, since, apart from ventral ocelli, and the shape of the parameres and sub-genital plates, both characters of little phylogenetic significance, there are no features common to the two groups. Of the three genera present in Australia, two, *Macropsis* Lewis and *Oncopsis* Burm., are of world-wide distribution, whilst *Stenoscopus* Ev. is confined to Western Australia.

The head, as far as Australian species are concerned, lies almost entirely in one plane, and a crown, if present, is very narrow. The ante-clypeus and lorae are frequently somewhat swollen, the maxillary plates narrow, the clypeal sutures directed outwards towards the eyes, and the antennal scrobes form a continuous line with them.

Frontal, epicranial, and coronal sutures may be faintly indicated, as shown on Plate VII, fig. 6 (*Oncopsis pullus* Ev.), or not apparent, and a pair of compact sausage-shaped markings indicate the attachments of the muscles of the sucking-pump. The fronto-clypeus is usually small, the vertex is large, and the whole head is generally punctate or rugose. The pronotum, which may be declivous or raised into a hump, narrows laterally (Plate IX, fig. 6), and the bases of the tegmina lie close behind the eyes. The tegmina have normal venation, and frequently several angular cells are developed; they are tectiform, have narrow appendices, and do not overlap apically. The wing venation is distinct, as R_{2+3} and R_{4+5} are fused for their entire length. The hind tibiae are not flattened nor curved, and have a row of evenly-spaced short, strong spines (Plate X, fig. 3).

Of the three genera, fifteen species of *Macropsis*, seven species of *Oncopsis*, and one species belonging to the genus *Stenoscopus*, have been described from Australia. These represent but a fraction of the large numbers that await description, and it is probable that an intensive study of the family would lead to the erection of several new genera. As far as is known, all members of this family inhabit trees and shrubs.

Tartessidae

(Plate IV, fig. 8; Plate VI, fig. 8; Plate VII, fig. 7; Plate X, fig. 7; Plate XI, fig. 11)

This family is erected to hold a very distinct group of genera, three of which occur in Australia (*Tartessus* Stål, *Tartessella* Ev., and *Tartessoides* Ev.). Previously these genera had been included in the Euscelidae (Evans, 1937, b).

The head is of particular interest, because in the nymphs of some species of *Tartessus*, the frons is a distinct sclerite, and even in the adult head traces may remain of the epistomal suture (Plate VII, fig. 7). The ocelli lie at the corner of the frons, close to the junction of the frontal and epicranial sutures, and may be either ventral, marginal, or dorsal, and the crown may consist entirely of the vertex or of the vertex and a narrow frontal margin. The tegmina have several cells, and a wide appendix that extends to the costal margin, and in *Sarpestus specularis* Spangb., a New Guinea species, traces remain of the sub-costal vein. In this genus the media is fused for the greater part of its length with the radius. The wing is unique amongst the Jassoidea, in having a marginal or ambient vein that continues on to the anal area. The hind tibae have three rows of long, strong spines and one row of fine hair-like spines, and between each of the spines of one row, all of which are set on swollen bases, occur a few minute spines. This development of minute interpolated spines is of little significance as it has occurred independently in several groups.

All species in this family are arboreal, and the Australian representatives, although not confined to eucalyptus trees, are principally associated with them.

Jassidae

(Plate VII, fig. 14)

This family is only known to me from two species belonging to the genus *Jassus* Fabr. The head of one of these, which is illustrated on Plate VII, fig. 14, is long and narrow, and the frontal sutures lie close to the eyes on each side. The ocelli are marginal, and the coronal suture joins the transverse epicranial suture at the apical margin of the head, thus the wide crown consists entirely of the vertex. The tegmina superficially resemble those of *Tartessus*, as the wide appendix continues as far as the costal border. The male genitalia are of interest, since the aedeagus is very long and the basal plates short.

Species in this family resemble the Tartessidae, as the epicranial suture lies along the ventral posterior margin of the head, and is transverse, but in the lengthening and narrowing of the face they differ widely from all other genera that have arisen from the Bythoscopoid stem. Only a single genus, *Tharra* Kirk., belonging to this family has been recorded from Australia.

Cicadellidae

(Plate VI, fig. 9; Plate VIII, fig. 9; Plate IX, fig. 13; Plate X, fig. 13)

This well-differentiated family needs little comment, its most outstanding characteristic being that not only does the hind-most portion of the fronto-clypeus form part of the crown, but the attachment impressions of the muscles of the sucking-pump extend on to the crown. The frontal sutures are also on the crown of the head and are always distinct, and traces may remain of a transverse epicranial and a longitudinal coronal suture. The ante-clypeus and the post-clypeus are usually swollen, the pronotum is wide laterally, and the tegmina long and narrow. The hind tibiae have an armature of strong spines, but lack spurs, and may have minute spines between each of the most prominent spines.

This family, members of which feed principally on grasses, is poorly represented in Australia, only one genus, *Cicadella* Latreille, having been recorded.

Euacanthidae

(Plate VII, fig. 16; Plate IX, fig. 14)

Euacanthus Le P. and S. does not occur in Australia, but three Australian species have been placed in a genus *Euacanthella* Ev., which is believed to be related to *Euacanthus*.

The family contains species that are similar in general appearance to members of the Cicadellidae, but which differ in that, although the hind portion of the fronto-clypeus extends on to the crown, the frontal sutures are ventral, the ocelli, though dorsal, are close to the margin of the head, and a transverse dorsal ridge marks the position of the epicranial suture. It is possible that the area between this ridge and the apex of the head represents the remains of the frons. The pronotum is wide laterally in *Euacanthus*, though narrow in *Euacanthella*, and in both genera the ante- and post-clypeus are swollen. The tegmina are short and rounded apically and lack a cross-vein (M_{1+2}) joining the media to the radius. The hind tibiae are armed with evenly-spaced spines of equal size mounted on slightly protuberant bases and with minute spines set between them. All species known to me are grass-feeders.

Pythamidae

(Plate VII, fig. 13)

This family is only known to me by one species, *Mainda praeculta* Dist., the head of which is figured, although two Australian genera, *Tortor* Kirk. and *Dryadomorpha* Kirk., have been described. For

particulars of the characteristics of this family, reference should be made to Baker, 1923. This author has pointed out that the Pythamidae have affinities to the Euacanthidae and Signoretidae rather than to the Cicadellidae.

Signoretidae

(Plate VI, fig. 10; Plate VII, fig. 15; Plate IX, fig. 15; Plate X, fig. 16)

No representatives of this Oriental family occur in Australia. A number of illustrations are given of *Preta gratiosa* Mel., and it will be seen that, although in cephalic characters this species would appear to be close to *Euacanthus*, the tegminal venation and armature of the hind tibiae are of a distinctive nature.

Nirvaniidae

(Plate VIII, fig. 11)

Four species contained in four genera have been described from Australia, but these insects are rare, and for a discussion of this family reference should be made to the work of Baker, mentioned above. The head of *Nirvana pallida* Mel. is figured; with this species the frontal sutures are short, and it is probable that the produced crown consists solely of the vertex.

Stenocotidae

(Plate V, fig. 8; Plate VIII, figs. 5, 6; Plate X, figs. 9, 11; Plate XI, figs. 8, 9)

The Stenocotidae, with the exception of a single genus, are confined to Australia. The face of the head is usually flattened and as wide as long, and the fronto-clypeus in certain species is separated into a frons and post-clypeus, the arched epistomal suture persisting in a reduced form (Plate VIII, fig. 5). The ocelli, which lie at the apices of the frontal sutures, may be ventral or dorsal or lie in marginal depressions. The tegmina in all Australian representatives have the anal veins fused apically, and the hind tibiae have distinct spurs, decreasing in size from the apex to the base. Sexual dimorphism occurs in some genera.

Baker (1923), in a discussion of the position of the genus *Koebelia* Baker, which occurs in Western North America, suggested that it lay between *Stenocotis* Stål and *Ulopa* Fall., but was sufficiently distinct from either to merit the erection of a family, the Koebeliidae, to contain it. This genus is now transferred to the Stenocotidae, because of the close similarity of head structure between *Kyphoctis tessellata* Kirk. and *Koebelia californica* Baker (Plate VIII, figs. 5 and 6). The resemblance is not confined to these two species, as the frons of *Stenocotis* is also similar in shape to that of *Koebelia*. A Y-vein is not developed with *Koebelia*, and the hind tibiae (Plate X, fig. 9), though lacking spur development, is of a

primitive type, from which that of *Stenocotis* might well have been derived. The male genitalia of *K. californica* and *Smicrotis* sp. are shown on Plate XI, figs. 8 and 9, and it will be noticed that both species have an aedeagus with a very long basal prolongation.

All the Australian Stenocotidae are arboreal and confined to eucalyptus trees. The habits of *K. californica* are unknown to me.

Ulopidae

(Plate VI, fig. 3; Plate VIII, fig. 1)

The Ulopidae are a family of small leaf-hoppers, members of which, according to Baker (1923), 'possess a character that is unique among jassoid insects, namely strongly rounded genae, the sharp outer edge of which curves mesad to the front above the lorae, leaving the latter with the outer border apparently free in facial view.'

On Plate VIII, fig. 1, is shown the head of the European *Ulopa reticulata* Fabr., with which the maxillary plates have been moved slightly out of position, and it will be seen that the distinctive characteristic of this family is nothing more than the persistence of the sub-genal suture, which, as shown in fig. 3 on the same plate (*Anacephaleus ulopae* Ev.), may also occur with the Ledridae, although exceptional in this family.

The Ulopidae are too well known to need further discussion, but it may be mentioned that the wide crown consists entirely of the vertex, and that ocelli, if present, lie well away from the frontal and epicranial sutures, having migrated to the crown independently of the backward development of the fronto-clypeus. One genus, *Austrolopa* Ev., has so far been described from Australia. It is believed that all species in this family feed on grasses.

Paropiidae

(Plate VIII, fig. 2)

The Paropiidae are another well-known family of small leaf-hoppers, and are related to the Ulopidae. As may be seen from the figure of the head of *Megophthalmus scanicus* Fall., the frontal and epicranial sutures are replaced by wide carinae, and the marginal depressions that contain the ocelli and the crown are formed from the vertex. A single genus, *Kahavalu* Kirk., has been recorded from Australia.

Ledridae

(Plate VI, fig. 5; Plate VIII, figs. 3, 4; Plate IX, figs. 11, 12; Plate X, figs. 14, 15; Plate XI, fig. 7)

The Ledridae comprise a heterogeneous collection of genera that might well be divided into three families, but which for the moment are grouped in three sub-families. The Ledrinae in which the Palaearctic genus *Ledra* F. occurs, contains six described Australian genera, *Ledropsis* White, *Ledramorpha* Stål, *Jukuruka* Dist., *Porcorhinus* Dist., *Rubria* Stål, and *Platyledra* Ev.

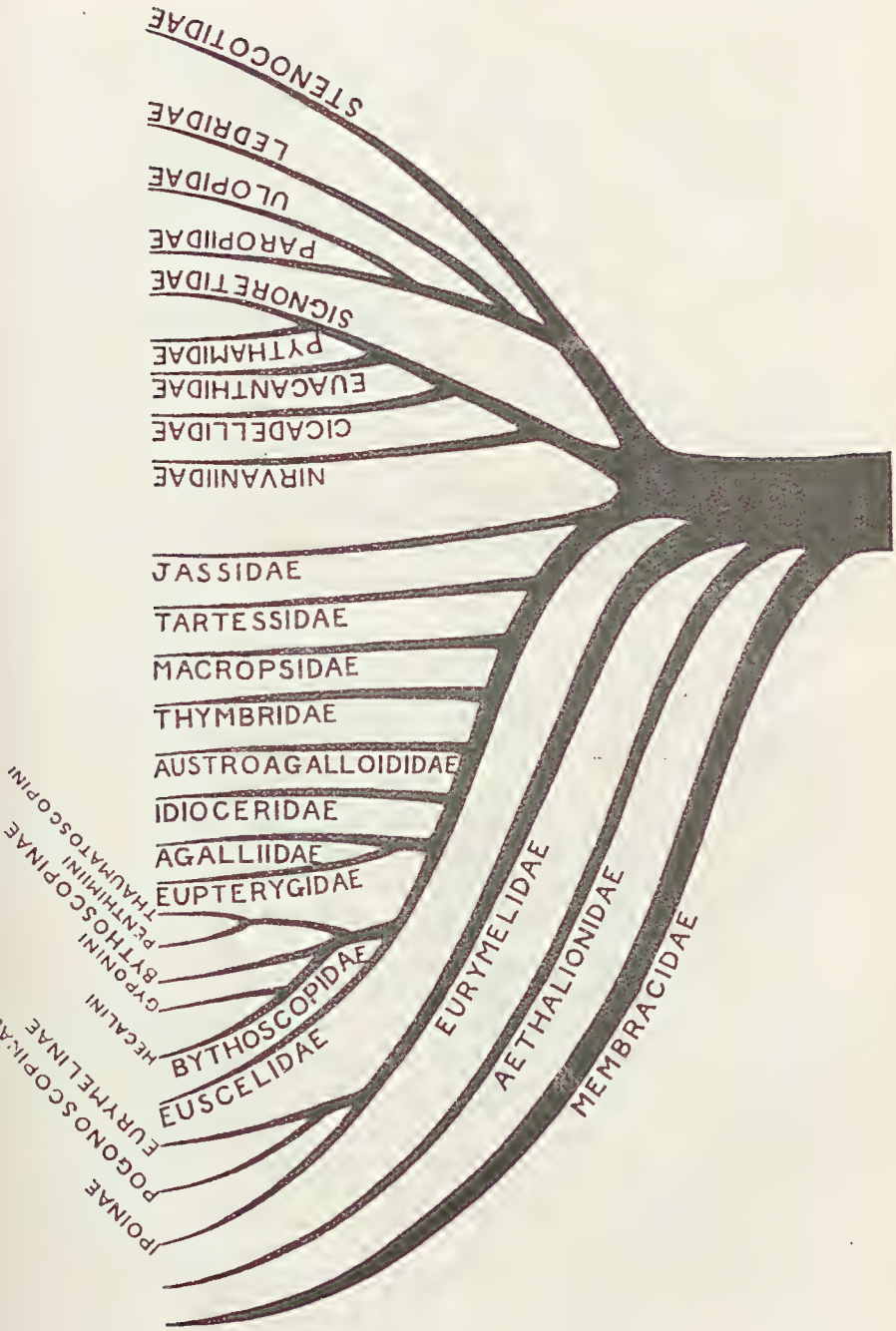
Insects in this sub-family have the head considerably flattened, widely produced, and concave ventrally. The ante-clypeus is narrow, often pear-shaped, and the post-clypeus includes nearly all that part of the head, both the face and the crown, that lies between the antennae and the ocelli. Although the coronal suture may appear to extend to the apex of the crown, a study of nymphal heads shows that it terminates close to the ocelli, and the obsolete frontal sutures, which are perceptible in *Ledropsis crocina* Dist., terminate at the ocelli. Thus the ocelli have migrated to their present dorsal position by way of the side of the head and not over the apical margin. The posterior median swollen ventral portion of the post-clypeus, although differentiated from the flattened lateral portions, is not separated from them by sutures; no well-marked antennal ledges are developed, and the eyes are prominent. The pronotum is collar-like, and may be raised into flap-like processes; the tegmina may have simple or recticulate venation, and the hind tibiae are considerably flattened and may lack spines or spurs, but usually one or a few spurs remain. In spite of the fact that species in the genus *Dorycephalus* Kirsch have marginal ocelli and hind tibiae with numerous spines, it is thought that they represent a primitive ledrid type, and are herewith transferred to the Ledrinae. The head and pronotum of *Dorycephalus platyrhynchus* Osb. is figured on Plate IX, fig. 12, and should be compared with that of *Rubria carnosa* Stål (fig. 11).

Two genera described recently (Evans, 1937, a), *Ledrella* Ev. and *Ledraprora* Ev., are placed in a new sub-family the Ledrellinae. Species in this group resemble those in the Ledrinae in the venation of the tegmina, in having prominent eyes and in the ocelli being on the crown, which in the case of *Ledraprora* is narrowly produced and consists almost entirely of part of the fronto-clypeus. The hind tibiae are flattened and similar in armature and shape to that figured on Plate X, fig. 3. They differ in the possession of distinct antennal ledges and a wide ante-clypeus; the head is not spatulate, and the pronotum, though wide laterally, is not collar-like.

The third sub-family, the Cephalelinae, has been defined previously (Evans, 1937, a). Insects in this group differ from those in the other two in their smaller size, in having deep antennal pits, in having the ventral posterior surface of the fronto-clypeus evenly concave or convex, not raised centrally, and in having hind tibiae which are not flattened, but short and feebly spinose. They resemble them in that the frontal and epicranial sutures are obsolete, the produced crown consists largely of the fronto-clypeus, the ocelli are on the disc of the crown, and the pronotum is collar-like.

Phylogenetic Tree

A phylogenetic tree is reproduced on p. 49 to indicate the possible inter-relationships of the various jassoid families. With only the Eurymelidae and Bythoscopidae are lesser divisions shown, and with the latter family only a few of the many that probably exist.


STENOCOTIDAE
LEDRIDAE
ULOPIDAE
PARopIIDAE
SIGNORETIDAE
PYTHAMIDAE
EUACANTHIDAE
CICADELLIDAE
NIRVANIIDAE
JASSIDAE
TARTESSIDAE
MACROPSIDAE
THYMBRIDAE
AUSTROAGALLOIDIDAE
IDIOCERIDAE
AGALLIIDAE
EUPTERYGIDAE
THAUMATOSCOPINI
PENTHIMIINI
BYTHOSCOPINI
GYPONINI
HECALINI
BYTHOSCOPIDAE
EUSCELIDAE
EURYMELINAE
POGONOSCOPINAE
IPOINAE
EURYMELIDAE
AETHALIONIDAE
MEMBRACIDAE

Habits and Food-Plants

Little is known about the habits of leaf-hoppers, but the Eurymelidae differ from all other jassoid families, with the possible exception of the Aethalionidae, in that they are ant-attended and the nymphs lack jumping powers. In only a few groups, such as the Eupterygidae, do both arboreal and grass-feeding species occur, and it is seldom that one species will feed indiscriminately on both types of plant, though it does happen, as recorded by DeLong (1923) in the case of *Gypona octolineata* (Say), which occurs on a variety of weeds, grasses, shrubs and trees. Very few specific food-plants of Australian leaf-hoppers have been recorded, but it is known that the majority feed on eucalyptus trees. Only one species (*Eurinoscopus elegans* Ev.) has been taken on *Acacia* spp., which, after the eucalypts, are the dominant Australian trees, and on which several species of membracids feed. None has been taken on any of the Proteaceae.

Whilst the Eurymelinae, Pogonoscopinae, and most of the Ipoinae, all the Thymbridae, Austroagalloididae, Stenocotidae, Australian Idioceridae, and most of the Tartessidae feed on eucalypts, none of the Macropsidae have been taken on these trees, but have been found on a variety of low-growing shrubs.

All the Australian Euacanthidae, Euscelidae, Ulopidae, Cicadellidae, Cephalelinae, and Agalliidae, so far as is known, feed on grasses, weeds, and plants of a similar habit. In general it is found that most leaf-hoppers with ventral ocelli are arboreal, whilst those with dorsal and marginal ocelli feed on grasses and other low-growing plants.

Size, Coloration and Sculpture

The size, coloration, and sculpture of leaf-hoppers are of assistance in determining relationships. It would seem that, with certain exceptions, the most primitive groups of present-day leaf-hoppers are small, and the general tendency has been towards an increase rather than a decrease in size. In the Eurymelidae, which includes the largest leaf-hoppers, the more generalized species, such as *Bakeriola procurrens*, are smaller than the more specialized, such as *Ipo pellucida* F. and *Eurymelops bicolor* (Burm.). Similar examples could be given for the Stenocotidae. All the Ulopidae are small, likewise the Cephalelinae and the large size of several Ledrids conforms with the idea that they may be highly specialized types descended from an extinct primitive stem. On the phylogenetic tree the Agalliidae and Eupterygidae are shown as arising from the same side-branch; this is because the factor of size as well as structure has been taken into account.

Leaf-hoppers are ornamented with a wide variety of colour patterns. In the Ledridae, Ulopidae, Paropiidae, and Stenocotidae, no

bright colours are developed, various shades of brown being predominant. In the Ipoinae and Pogonoscopinae yellow, black, and brown markings only occur, whilst the Eurymelinae, though largely black, may have vivid orange, red, and yellow coloration, but green, the principal pigment in many families, is never present.

The body-sclerites of most leaf-hoppers are smooth, yet many have transverse striations on the pronotum and raised carinae may be developed on the head and prothorax. All the Macropsidae have the head and pronotum punctate or rugose, as to a lesser extent is the case in the Austroagalloididae. This characteristic alone serves to differentiate these families from the Bythoscopidae.

Generic and Specific Differentiation

Any attempt to arrange the components of a group of insects of such ancient lineage as the Jassoidea into a system based on natural relationships, must always be complicated by two factors. First, the picture is incomplete, like a jig-saw puzzle of which most of the pieces are missing. Secondly, confusion is liable to occur because of parallel evolutionary trends. Considered as a whole, the Jassoidea are a remarkably homogeneous group, doubtless because they occupy the same environment during both their immature and adult life, and the types of environment available are limited, hence but few adaptive characters have been developed. They may be tree or shrub-inhabiting insects or live in pastures and similar environments; a few are myrmecophiles. Most of the arboreal forms are confined to a single species or genus of plants, and a few (certain Eupterygidae) have alternate seasonal food-plants, and migrate from deciduous to evergreen trees.

Five types of evolutionary development can be recognized. In one type new species and later genera have resulted from isolation, either geographical or as the result of the adoption and retention of a new food-plant. Such changes as accompany isolation usually lack direction, and may in the case of new food-plants be due to a physico-chemical reaction resulting from the nature of the cell-sap ingested. Another group of evolutionary changes is caused by a gradual re-orientation of muscle fibres that causes a change of shape of certain body sclerites. Changes of an orthogenetic nature that confer no benefit on the organism, and do not appear to be in response to any stimulus, also occur, and finally those of an adaptive nature and those due to mutations.

It is not proposed to discuss the classification on an evolutionary basis of all the families, but only to give examples selected from a few, and to show how, in many instances, it is difficult to decide upon the limits not only of genera, but also of species.

In the Eurymelidae genera are plentiful and species few, and the genera, which are clear-cut, may be of mutational origin. Certain species in this family (e.g., *Eurymela fenestrata*) have numerous

constant colour varieties, whilst in other species (e.g., *Eurymeloides punctata* Sign.) variable colour varieties occur. It is possible that some of these colour varieties may occupy different areas, or the same area, and may not inter-breed, and hence may represent incipient or true species. Possible incipient species also occur in such genera as *Rhotidoides*, where minor colour variation is often accompanied by slight structural differences largely affecting the extent of the crown. In the genus *Cicadella*, several Australian species occur with which changes in colour pattern are invariably accompanied by minor morphological changes. The above examples are concerned with specific differentiation; in other groups specific differences are well-established, but generic ones indefinite.

In the Bythoscopidae, *Neovulturnus lapsus* differs in head structure from *Thaumatoscopus dunkensis* to such an extent that the two species might well be placed in different families, yet a complete series of intergrades occurs between them. Similar series are found in the Cephalelinae between *Anacephaleus* Ev. and *Cephalelus* Perch, and in the Eupelicinae between *Dorydium* Burm. and *Paradorydium* Kirk. Such series of changes would appear to be along orthogenetic lines.

In the above instances species development has resulted from a progressive development in a definite direction, in each case concerned with the shape of the head. In many genera, such as *Oncopsis* and *Macropsis*, although species are distinct in colour pattern and morphological differences, no trends in any particular direction have been noted. In the Bythoscopidae it is believed that evolution has proceeded in several directions from a basic type resembling *Eurinoscopus*, whilst the present-day Ledrids, which give little evidence of evolutionary direction, are probably the remnants of an ancient group of which no primitive types survive.

Origins of Australian Fauna

In this section the problem of leaf-hopper distribution is only discussed from the Australian point of view. Of the twenty-one families given in the new classification, representatives of all but two, the Aethalionidae, which are confined to South America, and the Signoretidae, which are an Oriental family, occur in Australia.

Tillyard (1924) has given a table showing the known sources of the present Australian and New Zealand faunas, in which are ten divisions extending from Upper Permian to Late Tertiary times. Only four divisions need be considered here, of which the representative faunal elements are the Middle Austro-Malayan of Upper Cretaceous and Early Tertiary times, the Last Antarctic of Middle Tertiary times, the Autochthonous xerophytic element of Tertiary times, and the Late Austro-Malayan of Late Tertiary times.

It is suggested that the Bythoscopidae and Tartessidae are part of the Middle Austro-Malayan element, that the Euscelidae, Eupterygidae, Agalliidae, Macropsidae, and Idioceridae form part of the last Antarctic element that reached Australia in Mid-Tertiary times, and that the Jassidae, Euacanthidae, Pythamidae, Cicadellidae, and Nirvaniidae, none of which are well represented in Australia, and all of which are largely though not entirely confined to north-east Australia, form part of the Late Austro-Malayan element.

The Thymbridae and Austroagalloididae form part of the indigenous xerophytic fauna as do also the Stenocotidae, but the last named family, together with the Ulopidae, Ledridae, and Paropiidae, all of which are to-day represented by the survivors of an ancient well-distributed fauna, may have originated in Cretaceous or even earlier times. The Eurymelidae possibly belong to the Western Australian element of Cretaceous times.

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Note.

After the completion of this paper a small collection of leafhoppers was received from Dr. A. Zachvatkin. Amongst them was a specimen of *Macroceps ahnegeri* Mel. This species is not congeneric with the genotype, *Macroceps fasciatus* Sign., but, together with *Achrus nigronervosus* Lind., *Symphypyga leopardina* Hpt., and *S. albigutta* V.K., and doubtless other species, would appear to represent a distinct group, differing from any considered in the foregoing pages. All these insects have a fronto-clypeus that is considerably swollen, small antennal scrobes, a vertical vertex, and hence no development of a crown, rounded frontal and epicranial sutures, and no coronal suture. The tegmina may have recticulate venation, and the hind tibiae have two rows of closely-set slender spines and one row of widely-spaced spines, mounted on distinct but not prominent bases.

Several species of *Melicharella* Sem. were included in the collection. In spite of superficial differences in a number of morphological features, it is certain that this genus, and also *Symphypyga obsoleta* Hpt., are related to *Austroagalloides* and belong to the same family.

Unfortunately specimens of *Adelungia*, sent by Dr. Zachvatkin, were damaged in transit.

In addition to the above, a specimen of *Eupelix cuspidata* F. has been received from Mr. China. This species does not belong to the Euscelidae, and a consideration of its structure, sculpture, and coloration has led to the decision to place it in a sub-family of the Ledridae, the Eupelicinae.

References

Baker, C. F., 1915.—Studies in Phillipine Jassoidea 2. *Phillipine Journ. Sci.* 10. D; 49.

————, 1923.—The Jassoidea related to the Stenocotidae. *Phillipine Journ. Sci.* 22 (4); 345.

Carpenter, F. M., 1933.—Lower Permian Insects of Kansas Pt. 6. *Proc. Amer. Acad. Arts and Sci.* 68 (11).

China, W. E., 1926.—A new sub-family of the Bythoscopidae. *Trans. Ent. Soc. London;* 289.

Comstock, J. H., 1918.—*The Wings of Insects.* Comstock Publishing Co. N.Y.

De Long, D. M., 1923.—Cicadellidae, in Hemiptera of Connecticut. Bull. 34, *State Geol. and Nat. Hist. Survey.*

Evans, J. W., 1931.—Biology and Morphology of the Eurymelinae. *Proc. Linn. Soc. N.S.W.* 56 (3); 210.

————, 1933.—A Revision of the Eurymelini. *Trans. Roy. Soc. S. Aust.* 57; 73.

————, 1934.—A Revision of the Ipoinae. *Trans. Roy. Soc. S. Aust.* 58; 149.

————, 1936.—The Bythoscopidae of Australia. *Pap. Roy. Soc. Tas.* 1935-1936; 61.

————, 1937 (a).—Australian Leaf-Hoppers Pt. 4. *Pap. Roy. Soc. Tas.* 1936-1937; 37.

————, 1937 (b).—Australian Leaf-Hoppers Pt. 5. *Pap Roy. Soc. Tas.* 1936-1937; 51.

————, 1937 (c).—Australian Leaf-Hoppers Pt. 6. *Mem. Queensland Mus.* 11 (2); 149.

————, 1937 (d).—Australian Leaf-Hoppers Pt. 7. *Mem. Queensland Mus.* 11 (2); 157.

————, 1938.—The Morphology of the Head of Homoptera. *Pap. Roy. Soc. Tas.* 1937-1938; 1.

————, 1939.—Australian Leaf-Hoppers Pt. 8. *Pap. Roy. Soc. Tas.* 1938-1939; 1.

Funkhouser, W. D., 1913.—Homologies of the Wing Veins of Membracidae. *Ann. Ent. Soc. Amer.* 6; 74.

Handlirsch, A., 1908.—*Die Fossilen Insekten,* Leipsig.

Haupt, H., 1929.—Neueinteilung der Homoptera Cicadina. *Zool. Jahrbucher* 58; 256.

Imms, A. D., 1925.—*A General Text-Book of Entomology.* Methuen and Co. London.

Kennedy, C. H., 1928.—Evolutionary level in relation to geographic, seasonal and diurnal distribution of insects. *Ecology* 9 (4); 367.

Lawson, P. B., 1920.—Cicadellidae of Kansas. *Kansas Univ. Sci. Bull.* 12 (1).

Martynov, A., 1926.—Jurassic Fossil Insects from Turkestan. *Bull. Acad. Sci. U.S.S.R.*

Melichar, L., 1896.—*Cicadinen von Mittel-Europa.* Dames, Berlin.

Metcalf, Z. P., 1913.—The Wing Venation of the Jassidae. *Ann. Ent. Soc Amer.* 6; 103.

————, 1917.—The Wing Venation of the Cercopidae. *Ann. Ent. Soc. Amer.* 10; 27.

Naudé, T. J., 1926.—Cicadellidae of South Africa. *Ent. Mem.* 4. *S. Africa Dept. Agric.*

RIBAUT, H., 1936.—*Faune de France, Homoptères Auchénorhynques* 1. Paris Paul Lechevalier.

SEWARD, A. C., 1931.—*Plant Life through the Ages.* Cambridge University Press.

SINGH-PRUTHI, H., 1925.—Morphology of the Male Genitalia in Rhynchota. *Trans. Ent. Soc. London;* 127.

SNODGRASS, R. E., 1935.—*Principles of Insect Morphology.* McGraw Hill Book Co.

TILLYARD, R. J., 1920.—Mesozoic Insects of Queensland no. 7. *Proc. Linn. Soc. N.S.W.* 44 (4) ; 857.

———————, 1924.—Origin of Australian and New Zealand Insect Faunas. *Rept. A.A.A.S.* 16 ; 407.

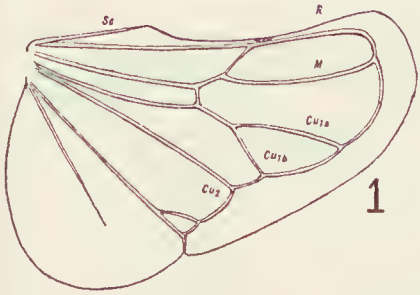
———————, 1926 (a).—Upper Permian Insects of N.S.W. Pt. 1. *Proc. Linn. Soc. N.S.W.* 51 (2) ; 1.

———————, 1926 (b).—*Insects of Australia and New Zealand.* Angus and Robertson, Sydney.

Explanation of Plates.

Plate IV

Fig. 1.—Wing of *Hindola compacta* (Cercopidae, Machaerotinae).
Fig. 2.—Wing of *Cercopis jactator* (Cercopidae, Cercopinae).
Fig. 3.—Wing of *Sextius virescens* (Membracidae).
Fig. 4.—Wing of *Aethalion reticulatum* (Aethalionidae).
Fig. 5.—Wing of *Eurymeloides punctata* (Eurymelidae).
Fig. 6.—Wing of *Bythoscopus lanio* (Bythoscopidae).
Fig. 7.—Wing of *Putoniessa rivularis* (Thymbridae).
Fig. 8.—Wing of *Tartessus fulvus* (Tartessidae).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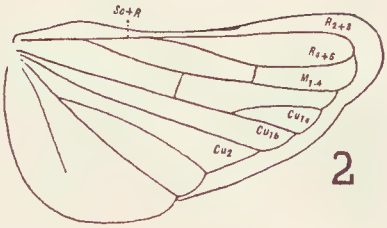
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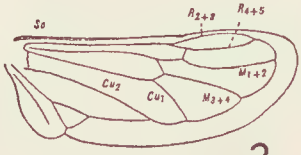
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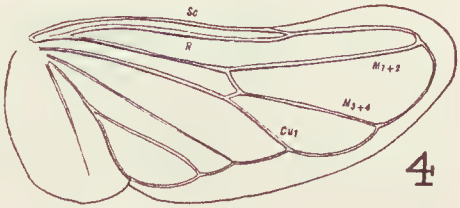
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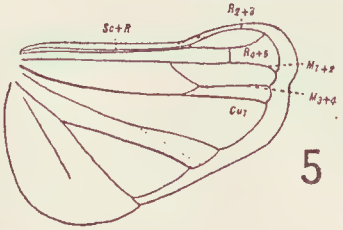
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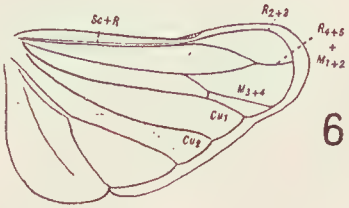
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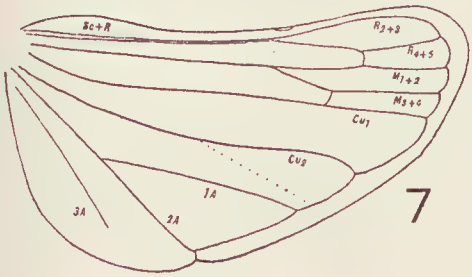
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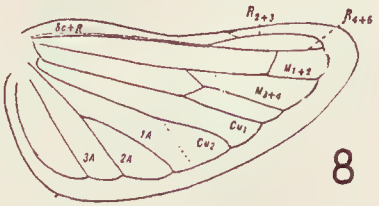
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Plate V

Fig. 1.—Hypothetical tegmen of common ancestor of Permian Homoptera. (After Carpenter, 1933.)

Fig. 2.—Hypothetical tegmen of common ancestor of recent Jassoidea.

Fig. 3.—Tegminal pad of pre-imaginal instar of *Eurymelops rubrovitatta.*

Fig. 4.—Tegmen of *Aethalion reticulatum* (Aethalionidae).

Fig. 5.—Tegmen of *Eurymelita terminalis* (Eurymelidae).

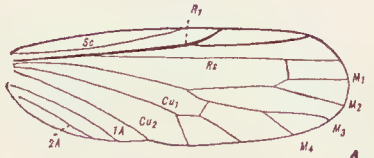
Fig. 6.—Tegmen of *Paradorydium menalus* (Euscelidae).

Fig. 7.—Tegmen of *Cornutipo scalpellum* (Eurymelidae).

Fig. 8.—Tegmen of *Kyphoctis tessellata* (Stenocotidae).

Fig. 9.—Tegmen of *Bakeriola procurrens* (Eurymelidae).

Fig. 10.—Tegmen of *Idiocerus seckeri* (Idioceridae).



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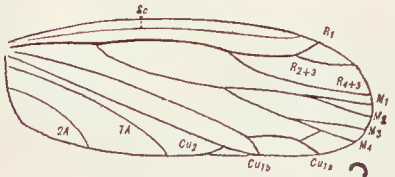

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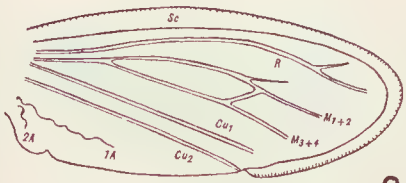

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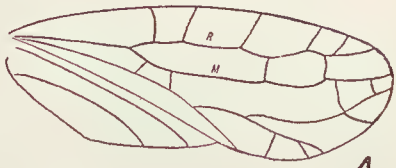

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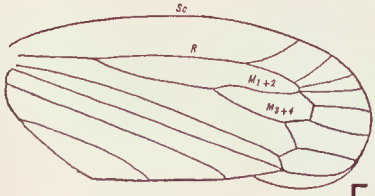

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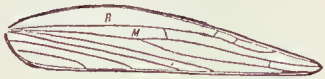

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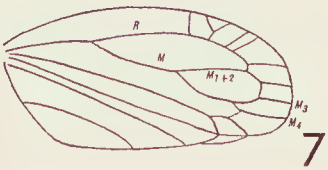

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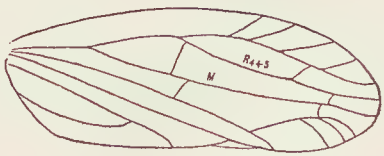

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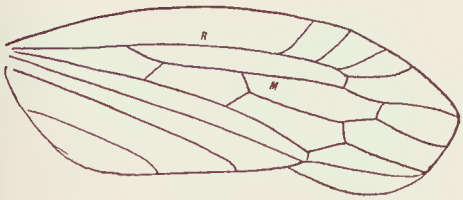

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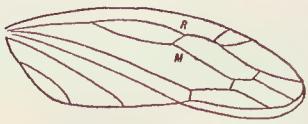

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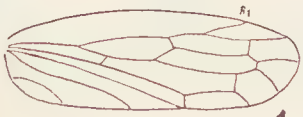
Plate VI

Fig. 1.—Tegmen of *Rubria sanguinea* (Ledridae).
Fig. 2.—Tegmen of *Macroceps tonnoiri* (Thymbridae).
Fig. 3.—Tegmen of *Austrolopa kingensis* (Ulopidae).
Fig. 4.—Tegmen of *Austroagalloides karoondae* (Austroagalloididae).
Fig. 5.—Tegmen of *Anacephaleus carribensis* (Ledridae).
Fig. 6.—Tegmen of *Trocnada gigantea* (Bythoscopidae).
Fig. 7.—Tegmen of *Stenoscopus drummondi* (Macropsidae).
Fig. 8.—Tegmen of *Sarpestus specularis* (Tartessidae).
Fig. 9.—Tegmen of *Cicadella pasiphae* (Cicadellidae).
Fig. 10.—Tegmen of *Signoretia aureola* (Signoretidae).



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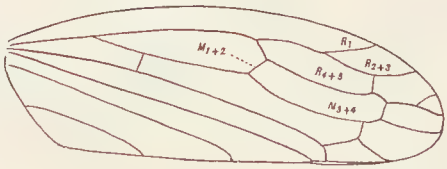

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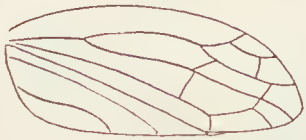

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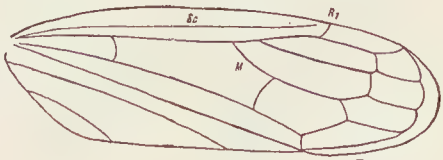

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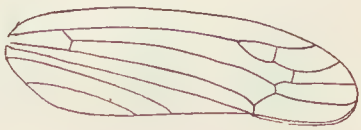

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Plate VII

Figs. 1 and 2.—Head of *Penthimia americana* (Bythoscopidae).
Figs. 3 and 4.—Head of *Trocnada gigantea* (Bythoscopidae).
Fig. 5.—Head of *Austroagalloides nigra* (Austroagalloididae).
Fig. 6.—Head of *Oncopsis pullus* (Macropsidae).
Fig. 7.—Head of *Tartessus blundellensis* (Tartessidae).
Fig. 8.—Head of *Opio multistrigia* (Eurymelidae).
Fig. 9.—Head of *Aethalion reticulatum* (Aethalionidae).
Fig. 10.—Head of *Macroceps fasciatus* (Thymbridae).
Fig. 11.—Head of *Austroagallia torrida* (Agalliidae).
Fig. 12.—Head of *Idiocerus leurensis* (Idioceridae).
Fig. 13.—Head of *Mainda praeculta* (Pythamidae).
Fig. 14.—Head of *Jassus indicus* (Jassidae).
Fig. 15.—Head of *Preta gratiosa* (Signoretidae).
Fig. 16.—Head of *Euacanthus interruptus* (Euacanthidae).

cs., coronal suture; es., epicranial suture; fs., frontal suture; v., vertex; eps., epistomal suture; fc., fronto-clypeus; ac., ante-clypeus; cls., clypeal suture.

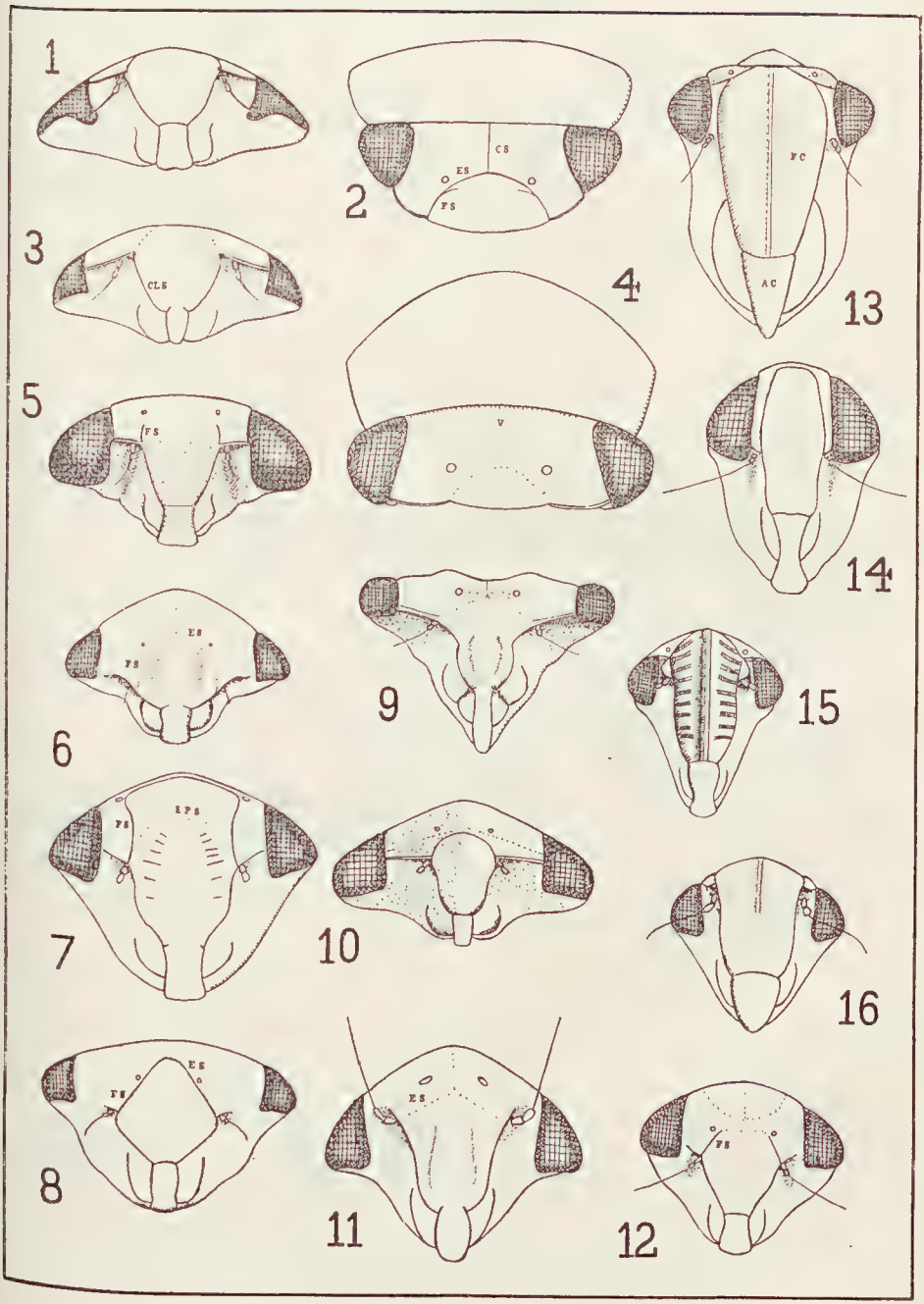
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Plate VIII

Fig. 1.—Head of *Ulopa reticulata* (Ulopidae).
Fig. 2.—Head of *Megophthalmus scanicus* (Paropiidae).
Fig. 3.—Head of *Anacephaleus ulopae* (Ledridae).
Fig. 4.—Head of *Ledropsis crocina* (Ledridae).
Fig. 5.—Head of *Kyphoctis tessellata* (Stenocotidae).
Fig. 6.—Head of *Koebelia californica* (Stenocotidae).
Fig. 7.—Head of *Reuteriella flavescens* (Bythoscopidae).
Fig. 8.—Head of *Gypona angulata* (Bythoscopidae).
Fig. 9.—Head of *Cicadella circulata* (Cicadellidae).
Fig. 10.—Head of *Deltocephalus obliquus* (Euscelidae).
Fig. 11.—Head of *Nirvana pallida* (Nirvaniidae).
Fig. 12.—Head of *Typhlocyba ulmi* (Eupterygidae).

sgs., sub-genal suture; f., frons; pc., post-clypeus; fs., frontal suture; es., epicranial suture.

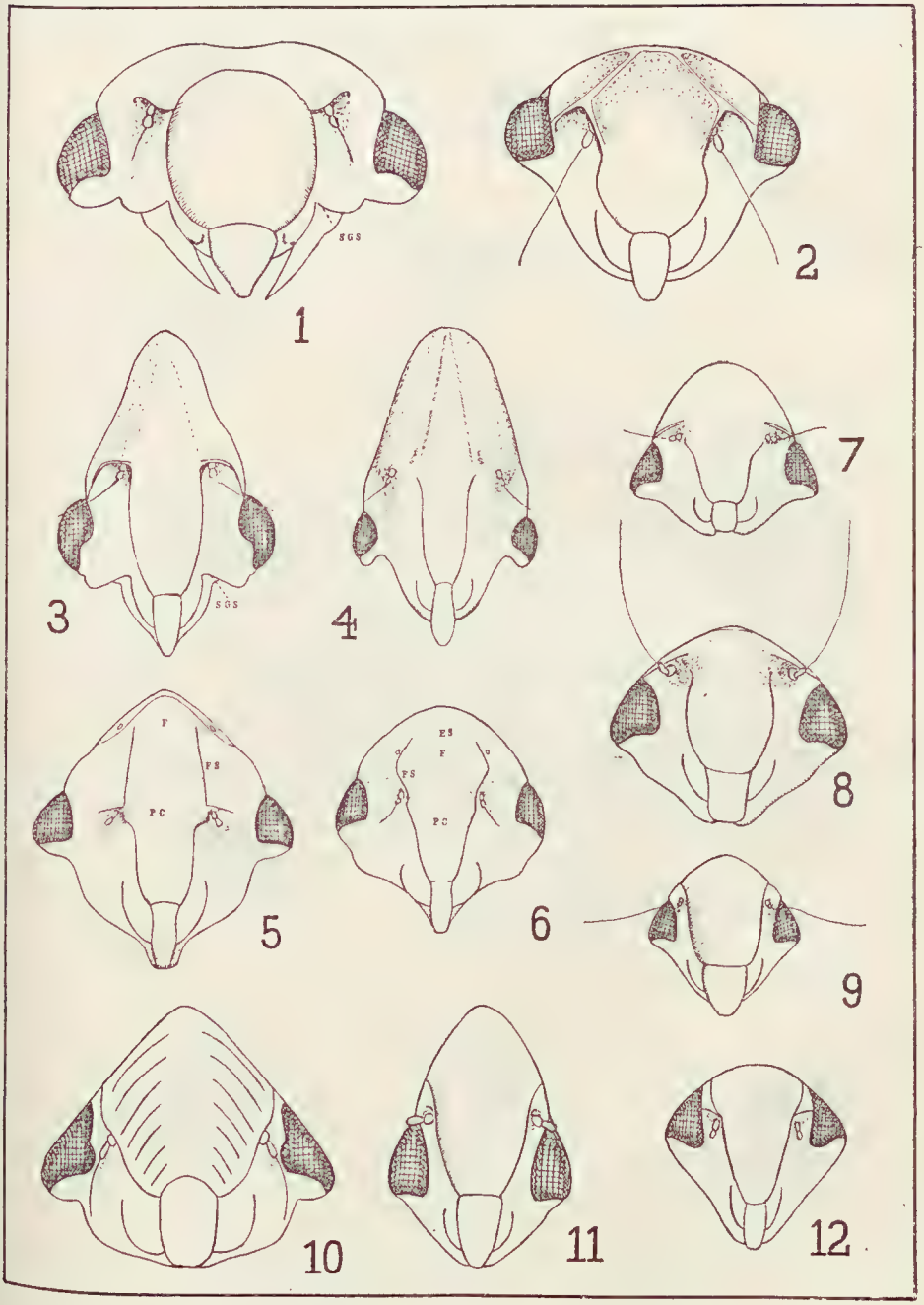
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Plate IX

Fig. 1.—Head and Prothorax of *Eurinoscopus viridis* (Bythoscopidae).
Fig. 2.—Head and Prothorax of *Penthimia americana* (Bythoscopidae).
Fig. 3.—Head and Prothorax of *Reuteriella flavescens* (Bythoscopidae).
Fig. 4.—Head and Prothorax of *Hecalus lineatus* (Bythoscopidae).
Fig. 5.—Head and Prothorax of *Gypona angulata* (Bythoscopidae).
Fig. 6.—Head and Prothorax of *Oncopsis pullus* (Macropsidae).
Fig. 7.—Head and Prothorax of *Rhotidoides norfolkensis* (Thymbridae).
Fig. 8.—Head and Prothorax of *Idiocerus leurensis* (Idioceridae).
Fig. 9.—Head and Prothorax of *Chlorotettix unicolor* (Euscelidae).
Fig. 10.—Head and Prothorax of *Austroagalloides nigra* (Austroagalloididae).
Fig. 11.—Head and Prothorax of *Rubria carnosa* (Ledridae).
Fig. 12.—Head and Prothorax of *Dorycephalus platyrhynchus* (Ledridae).
Fig. 13.—Head and Prothorax of *Oncometopia suturalis* (Cicadellidae).
Fig. 14.—Head and Prothorax of *Euacanthus acuminatus* (Euacanthidae).
Fig. 15.—Head and Prothorax of *Preta gratiosa* (Signoretidae).

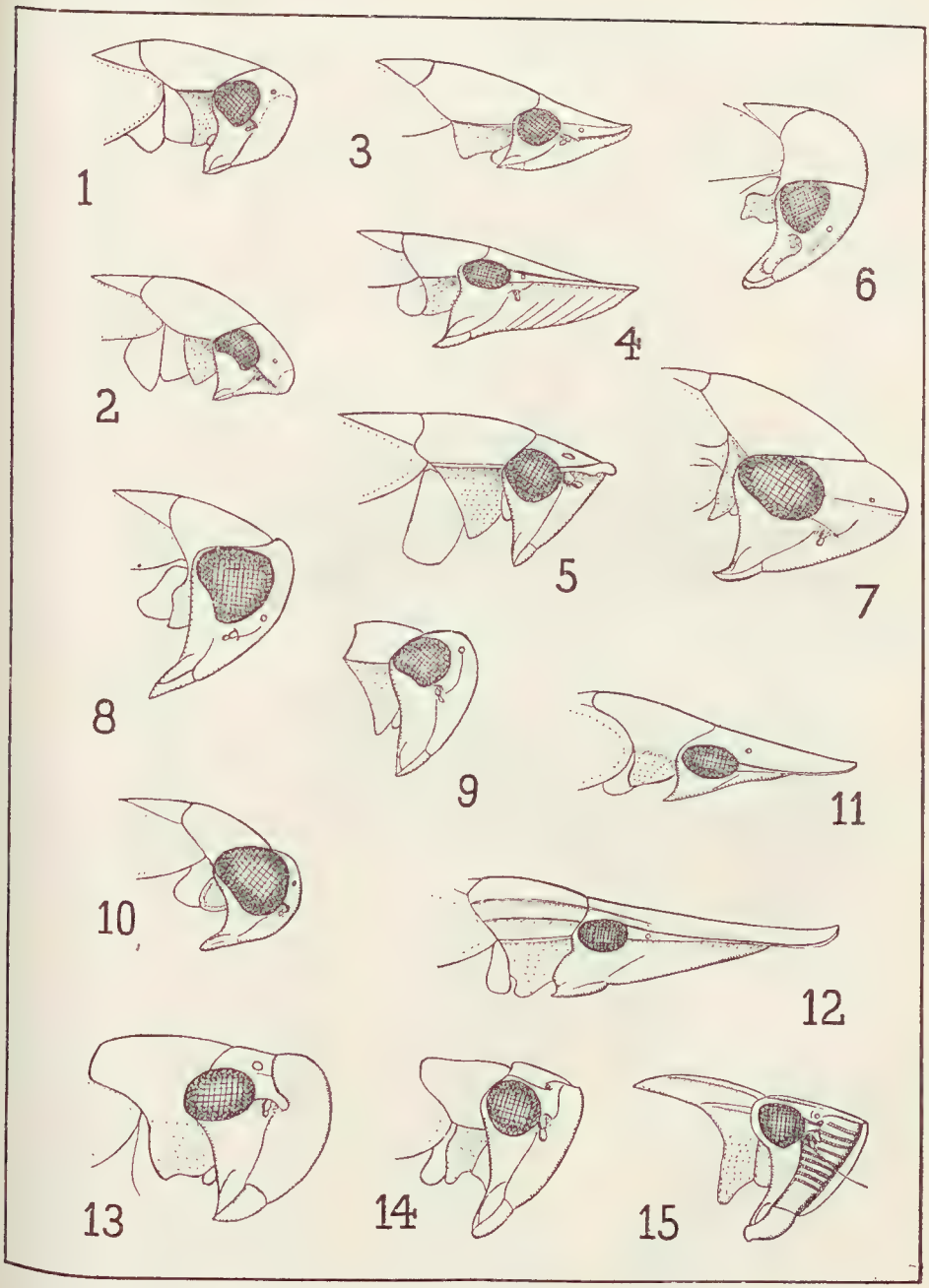
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Plate X

Fig. 1.—Hind Tibia of *Eurinoscopus viridis* (Bythoscopidae).
Fig. 2.—Hind Tibia of *Idiocerus kirkaldyi* (Idioceridae).
Fig. 3.—Hind Tibia of *Macropsis victoriensis* (Macropsidae).
Fig. 4.—Hind Tibia of *Bakeriola procurrens* (Eurymelidae).
Fig. 5.—Hind Tibia of *Eurymelops bicolor* (Eurymelidae).
Fig. 6.—Hind Tibia of *Lasioscopus acmaeops* (Eurymelidae).
Fig. 7.—Hind Tibia of *Tartessus fulvus* (Tartessidae).
Fig. 8.—Hind Tibia of *Rhotidus leurensis* (Thymbridae).
Fig. 9.—Hind Tibia of *Koebelia californica* (Stenocotidae).
Fig. 10.—Hind Tibia of *Aethalion reticulatum* (Aethalionidae).
Fig. 11.—Hind Tibia of *Stenocotis depressa* (Stenocotidae).
Fig. 12.—Hind Tibia of *Macroceps tamarensis* (Thymbridae).
Fig. 13.—Hind Tibia of *Cicadella richmondensis* (Cicadellidae).
Fig. 14.—Hind Tibia of *Rubria sanguinea* (Ledridae).
Fig. 15.—Hind Tibia of *Ledropsis crocina* (Ledridae).
Fig. 16.—Hind Tibia of *Preta gratiosa* (Signoretidae).

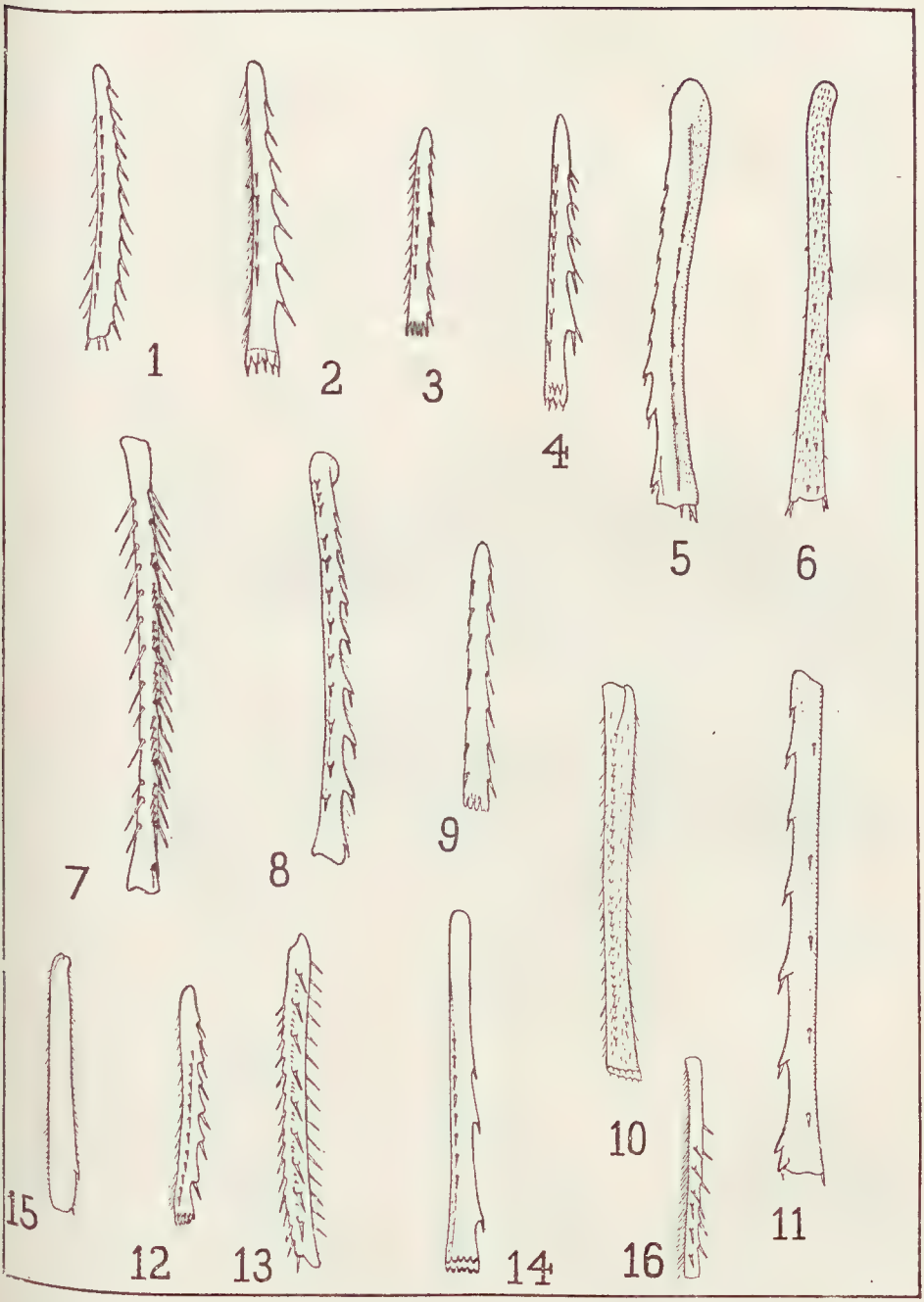
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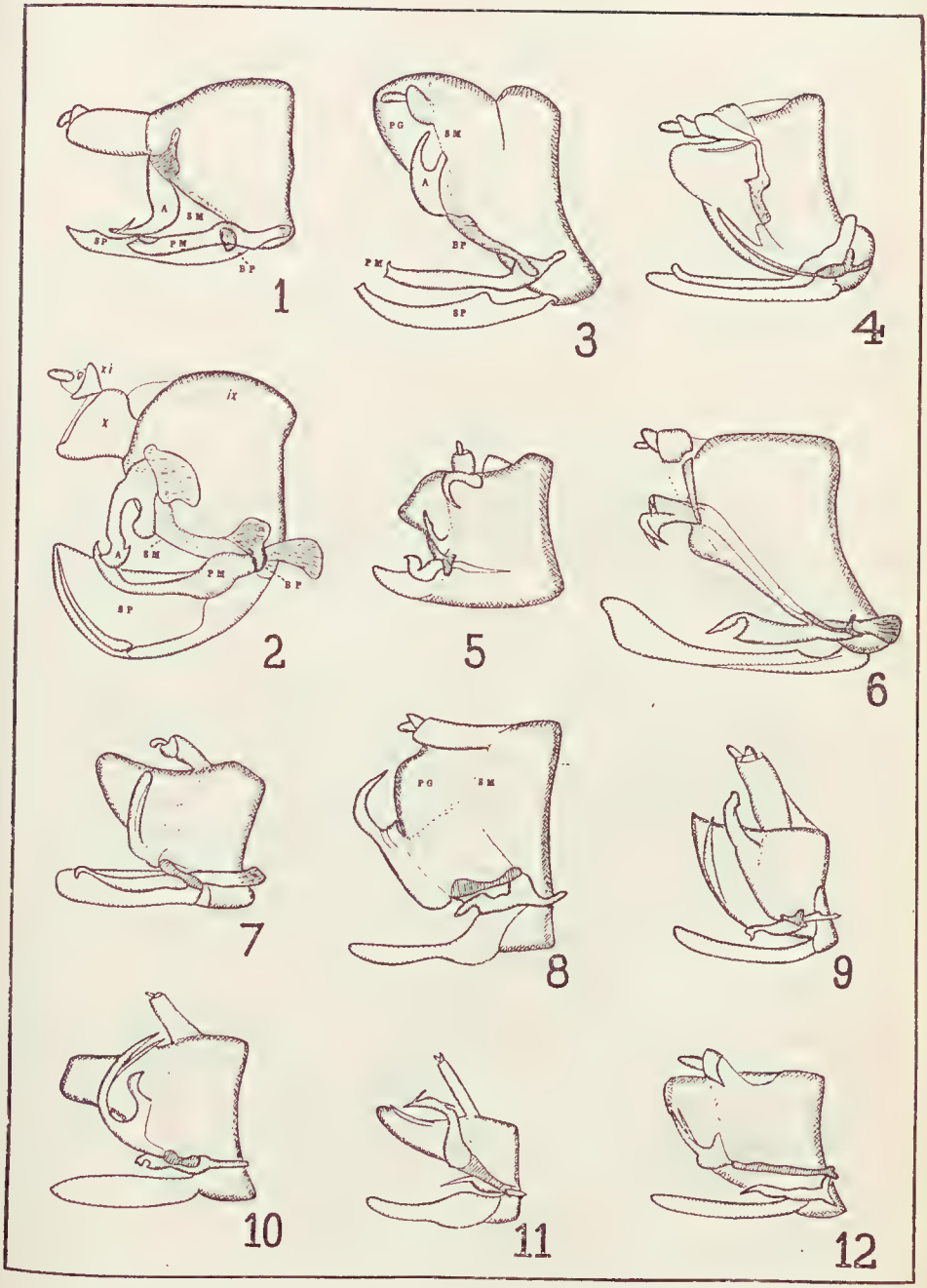
Plate XI

Fig. 1.—Male Genitalia of *Bakeriola procurrens* (Eurymelidae).
Fig. 2.—Male Genitalia of *Eurymela fenestrata* (Eurymelidae).
Fig. 3.—Male Genitalia of *Eurinoscopus viridis* (Bythoscopidae).
Fig. 4.—Male Genitalia of *Macropsis tasmaniensis* (Macropsidae).
Fig. 5.—Male Genitalia of *Austroagallia torrida* (Agalliidae).
Fig. 6.—Male Genitalia of *Idiocerus kirkaldyi* (Idioceridae).
Fig. 7.—Male Genitalia of *Ledropsis crocina* (Ledridae).
Fig. 8.—Male Genitalia of *Koebelia californica* (Stenocotidae).
Fig. 9.—Male Genitalia of *Smicrotis* sp. (Stenocotidae).
Fig. 10.—Male Genitalia of *Hackeriana glauca* (Thymbridae).
Fig. 11.—Male Genitalia of *Tartessus idyia* (Tartessidae).
Fig. 12.—Male Genitalia of *Euscelis stactogalus* (Euscelidae).

a., aedeagus; sm. segmental membrane; bp., basal plate; sp., sub-genital plate; pm., paramere; pg., pygophore.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A Second Revision of the Lepidoptera of Tasmania.

By

A. Jefferis Turner, M.D., F.R.E.S.

Twelve years have passed since I attempted a revision of the Tasmanian Lepidoptera.* The inception of the Biological Survey of Tasmanian has recalled me to this task. Much new material has been collected, of which most came from three summer visits which I made in 1935, 1937, and 1938, supplemented by a collecting trip made by Mr. G. M. Goldfinch, of Sydney, this year. Unfortunately resident collectors in the island are still very few. I received some specimens from Mr. I. Harman, who resided several years at Snug, near Hobart. Capt. D. C. Pearse has given me valuable assistance, and I have received specimens also from Mr. and Mrs. Davis (G. and C. Davis). Among the older collectors mentioned in my revision, I omitted to mention Mr. A Simson, who reared some interesting species from larvae in the Launceston district.

Altogether these additions have considerably increased our knowledge of the island lepidoptera, and of their range of distribution. Of the butterflies and larger moths our knowledge appears fairly complete. Though new species of the latter are still being discovered, their number is comparatively small. On the other hand, many new microlepidoptera have been added to our list. This section is still imperfectly known, and many new discoveries await the collector. An example of this is the new species of *Phyllocnistis*, recently found in his own garden by Dr. V. V. Hickman, of Hobart University. He has made valuable observations on its life history. Very little has yet been done in the study of the larvae in Tasmania.

* A. Jefferis Turner, 1926.—New and Little-known Tasmanian Lepidoptera. *Pap. Roy. Soc. Tas.*, 1925, pp. 81-117.

———— 1926.—A Revision of the Lepidoptera of Tasmania. *Pap. Roy. Soc. Tas.*, 1925, pp. 118-151.

————, 1927.—New and Little-known Tasmanian Lepidoptera, Part II. *Pap. Roy. Soc. Tas.*, 1926, pp. 119-164.

I may mention that an example of the large migratory North American butterfly *Danais archippus* has recently been captured near Launceston. This species is now well established in all the mainland States, the larvae feeding on the introduced weeds *Asclepia curassiva* and *Gomphocarpus fructicosus.* Unless these occur on the island, which is doubtful, the species cannot establish itself here.

This second revision consists of five parts. (1) Omissions and alterations which should be made in the former list. (2) A list of a few species formerly known only from Tasmania, which have since been discovered on the Australian continent. (3) A much longer list of Australian species, which have been taken during the last twelve years in Tasmania. (4) Descriptions of 87 new species and 6 new genera. (5) Additional localities for species included in the original revision.

Omissions and Alterations in Former List

Nymphalidae. Satyrinae

Oreixenica lathoniella Westw.

I have taken the form *laranda* W. & L. at Waratah and Strahan, and am now convinced that it is not a distinct species. It is very near the form I have described as *barnardi,* but the underside of the hindwings is often darker and the basal silvery spots often narrower. On a longer series I believe the two forms would be found to be indistinguishable. Waratah is only separated by 30 miles of elevated land from Cradle Mountain, and if the two forms were genetic races, I do not think they could co-exist. I suggest that the differences result from climatic conditions, probably acting on the larvae; and I am inclined to extend the same explanation to the differences between *barnardi* and the typical *lathoniella.* This hypothesis is open to proof or disproof by breeding experiment.

Hesperidae

For *Padraona* Moore *Ocybadistis* Heron should be substituted. It has recently been shown that two species have been confused under the name *flavovittata* Latr. Of these *O. walkeri* has been taken at Burnie. To which species the other locality records refer is at present doubtful, but it is possible that the true *O. flavovittata* also occurs in Tasmania.

Larentiadae

Poecilasthena aedaea Turn. should be omitted. It is a synonym for *Minoa euthecta* Turn., which should be added to the list.

Microdes typhopa Low. is a South Australian species, and it is doubtful whether it occurs in Tasmania. I suspect there has been an error.

Eccymatoge iopolia Turn. should be transferred to the genus *Poecilasthena.*

Eucymatoge liometopa Turn. is a synonym of *Eccymatoge morphna* Turn., a species that occurs on Australian mountains.

Euphyia bichromata Gn. is an older name for *E. languescens* Rosen.

Acalaphes Turn. I now refer this anomalous genus to the *Boarmiadae.*

Acalyphes philorites Turn. I took four additional male examples in Cradle Valley in February. They were flying rather strongly by daylight on the edges of the beech forest. In spite of the anastomosis of 12 of the hindwings with the cell, I now regard this genus as closely allied to, in fact a development of, *Dirce* Prout. In other respects the neuration of the hindwings is identical for what I took for vein 5 appears to be only a fold of the wing membrane.

Boarmiadae

Ecpatites callipolia Turn. is a synonym of *Mictodoca toxeuta* Meyr.

Oenochromidae

Taxeotis inconcisata Wlk. *T. intextata* Gn. is an older name, and must be substituted.

Arctiadae

Hestiarcha atala Turn. is a synonym of *Thermeola tasmanica* Hmps.

Noctuidae. Agaristinae

Radinocera placodes Low. is a Queensland species. The Tasmanian locality is erroneous.

Acronyctinae

In my opinion the genus *Peripyra* Hmps. should be considered a synonym of *Amphipyra* Ochs.

Ophiderinae. (Noctuinae)

I believe the Tasmanian locality for *Sandava xylistis* to be erroneous; at least it requires verification.

Crambidae

For *Thinasotia* Hb, substitute *Platytes* Gn.

Tortricidae

Tortrix hemiphoena Turn. I now believe to be the same species as *T. eurystropha* Turn. It extends to Queensland. The latter name has priority.

Capua poliobaphes and *C. asemantica.* Having obtained a long series, I am now of opinion that these are one species.

Elachistidae

Labdia autotoma should be transferred to the allied genus *Stagmatophora.*

Gelechiadae

Aristotelia bacillum Turn. is a synonym of *Iulota epispila* Low.

Oecophoridae

Leptocroca silicolor Turn. is a synonym of *Borkhausenia acalles* Turn..

Leptocroca epimicta Meyr. Delete Russell Falls.

Locheutis inconcinna Turn. is a synonym of *Barea arbitra* Meyr

Oenochroa phoenochyta Turn. I have made this the type of the genus *Eucryphaea,* P.L.S.N.S.W., 1935, p. 329.

Barea heterophanes Turn. is a synonym of *B. helica* Meyr.

Barea hypselotropha is a synonym of *Eulechria umbrosa* Meyr.. which is a true *Barea.*

Barea semocausta Meyr. Delete all localities, except Deloraine.

Orescoa Turn. I now merge in the genus *Elaeonoma.*

The following species should be transferred from *Eulechria* to *Macronemata* Meyr., P.L.S.N.S.W., 1883, p. 345 (as defined by myself in P.L.S.N.S.W., 1936, p. 303), *suppletella, textilis, tacita,* and perhaps *paurogramma* (which I have not seen).

Eulechria cirrhopis Turn. should be transferred to *Elaeonoma.*

Eulechria oxypeuces Turn. should be transferred to *Borkhausenia.*

Machaeretis psathyra Meyr. Delete all localities, except Hobart.

Phlobota crepera Meyr. should be transferred to *Eulechria.*

Phlobota ethnitis Meyr. is a synonym of *Eulechria myriospila* Low.

Phlobota pandora Turn. should be transferred to *Chrysonoma.*

Eochrois cirrhophara Turn. should be transferred to *Philobota.*

Sphyrelata ochrophaea should be transferred to *Eulechria.*

Tasmanian Species now Known to Occur on the Australian Continent.

These were marked with an asterisk in the former revision.

Microdes diplodonta Turn., from Ebor, N.S.W.

Amelora cyclocentra Turn., from Mt. Buffalo (4000 ft.), Vic.

Porela subfasciata Turn., from Moe, Vic.

Epipaschia amaurodes Turn., from Mt. Buffalo, Vic.

Tortrix polyphrica Turn., from Mt. Buffalo, Vic.

Carposina latebrosa Meyr., from Southport, Q.

Borkhausenia oxypeuces (Eulechria) Turn., from Beaconsfield, Vic.

Philobota ceratina Meyr., from Mt. Kosciusko (3500 ft.), N.S.W.

Eutorna leptographa Meyr., from Moe, Vic.

Eutorna phaulocosma Meyr., from Mt. Kosciusko (3500 ft.), N.S.W.

Australian Species not Recorded in Previous Revision.

Larentiadae

Minoa euthecta Turn. P.R.S., Vic., 1903, p. 243, P.L.S.N.S.W., 1906, p. 697. Allowing for individual differences, Tasmanian examples do not appear distinguishable from those taken in southern Queensland, Russell Falls, Burnie, Rosebery, Strahan. I have also seen an example from Gisborne, Victoria.

Poecilasthena oceanias Meyr. P.L.S.N.S.W., 1890, p. 816. Mt. Wellington (2500 ft.), Weldborough, Burnie, Rosebery, Zeehan.

Eccymatoge morphna Turn. Tr. R.S.S.A., 1922, p. 192. Hobart, Russell Falls, Strahan.

Larentia dascia Turn. P.R.S., Vic., 1903, p. 275. Tasman Peninsula, Coles Bay, Derwent Bridge.

Melitulias oriadelpha Turn. Tr. R.S.S.A., 1926, p. 122. Cradle Mount (3000 ft.).

Euphyia trissocyma Turn. Tr. R.S.S.A., 1922, p. 252. St. Helens (Goldfinch).

Diploctena pantoca Turn. P.L.S.N.S.W., 1907, p. 634. Waratah (Goldfinch).

Geometridae

Pingasa muscosaria Gn., ix, p. 281. Goldfinch, P.L.S.N.S.W., 1929, p. 390. Hobart.

Boarmiadae

Ectropis pristis Meyr. P.L.S.N.S.W., 1891, p. 625. Coles Bay and St. Helens (Goldfinch).

Ectropis aganopa Meyr. P.L.S.N.S.W., 1891, p. 610. Hobart.

Psilosticha integraria Wlk. is the correct name for *P. mactaria* (Meyr. nec Gn.). Hobart, St. Helens.

Boarmia leucoplecta Meyr. P.L.S.N.S.W., 1891, p. 607. Waratah (Goldfinch).

Boarmia chionomera Low. Tr. R.S.A., 1893, p. 159. Russell Falls (Goldfinch).

Boarmia loxographa Turn. P.L.S.N.S.W., 1917, p. 353. Weldborough.

Boarmia atycta Turn. Mr. G. M. Goldfinch informs me that this is synonym of *Psilosticha mactaria* Gn. (nec Meyr.).

Casbia rhodina Turn. Coles Bay (Goldfinch).

Idiodes prionosema Turn. P.L.S.N.S.W., 1919, p. 291. Strahan.

Amelora zophopasta Turn. P.L.S.N.S.W., 1919, p. 301. Hobart.

Chlenias pini Tind. Rec. S.A. Mus.

Oenochromidae

Dichromodes exsignata Wlk. (nec Meyr.), xxiii, p. 1010 (accidentally omitted) (syn. *D. diasemaria* Meyr. P.L.S.N.S.W., 1889, p. 1171). Tasman Peninsula, St. Helens, Beaconsfield, Zeehan, Strahan, Cradle Mountain (3000 ft.).

Notodontidae

Gallaba duplicata Wlk., xxxii, p. 458. Turn. P.L.S.N.S.W., 1903, p. 68. Hobart.

Arctiadae

Calamidia hirta Wlk., ii, p. 510. Meyr. P.L.S.N.S.W., 1886, p. 694. Burnie.

Noctuidae. Acronyctinae

Bathytricha Turn. Tr. R.S.S.A., 1920, p. 150, *truncata* Wlk., ix, p. 111. Launceston.

Caradrina cyanoloma Low. P.L.S.N.S.W., 1902, p. 647. Coles Bay, Devonport.

Caradrina loxosema Turn. Tr. R.S.S.A., 1908, p. 55. Hobart, Cradle Mountain (3000 ft.).

Caradrina porphyrescens Low. P.L.S.N.S.W., 1902, p. 652. Waratah.

Caradrina microspila Low. P.L.S.N.S.W., 1902, p. 648. Deloraine, Devonport.

Hypeninae

Bracharthron Hamps. (Ill. Het., viii, p. 99), *ossicolor* Rosen. Scottsdale, Strahan.

Phycitidae

Crocydopora Meyr. P.L.S.N.S.W., 1882, p. 158, *cinigerella* Wlk., xxxv, p. 1719. Strahan.

Crambidae

Diptychophora dilatella Meyr. P.L.S.N.S.W., 1878, p. 199. Hobart.

Pyralidae

Catamola capnopis Meyr. Tr. E.S., 1885, p. 439. Ulverstone (Goldfinch).

Macalla thyridalis Wlk., xvi, p. 167. Meyr., Tr. E.S., p. 64. Cygnet.

Pyraustidae

Metallarcha Meyr. (Tr. E.S., 1884, p. 331), *diplochrysa* Meyr Tr. R.S., 1884, p. 332. King Island.

Criophthona Meyr. (Tr. E.S., 1884, p. 339), *celaenophaes* Turn. P.R.S.Q., 1912, p. 151. Coles Bay (Goldfinch).

Scoparia crocospila Turn. P.R.S., Vic., 1922, p. 53. Hobart.

Tortricidae

Acropolitis excelsa Meyr. P.L.S.N.S.W., 1910, p. 172. Strahan.

Capua solana Wlk., xxviii, p. 300. Meyr., P.L.S.N.S.W., 1881, p. 476. Weldborough.

Capua leucostacta Meyr., 1910, p. 202. Weldborough.

Tortrix cerussata Meyr. P.L.S.N.S.W., 1910, p. 234. Mt. Wellington (1500-3000 ft.), Waratah.

Epichorista microstictis Meyr. P.L.S.N.S.W., 1910, p. 260. Cradle Mountain (2000 ft.).

Epichorista hyperacria Turn. Tr. R.S.S.A., 1916, p. 515. Cradle Mountain (3000 ft.).

Epichorista leptosticta Turn. Tr. R.S.S.A., 1916, p. 516. Cradle Mountain (3000ft.).

Arotrophora xythopterana Meyr. P.L.S.N.S.W., 1881, p. 529. Derwent Bridge and Waratah (Goldfinch).

Arothrophora ammodes Meyr. P.L.S.N.S.W., 1910, p. 265. Derwent Bridge.

Cnephasia mermera Meyr. P.L.S.N.S.W., 1910, p. 277. Weldborough (Goldfinch). This is the first Tasmanian example I have seen. I now accept Meyrick's locality, Mt. Wellington (3000 ft.).

Cnephasia rupicolana Meyr. P.L.S.N.S.W., 1881, p. 526. Hobart.

Eucosmidae

Spilonota zopherana Meyr. P.L.S.N.S.W., 1881, p. 230. Mt. Barrow (Goldfinch).

Elachistidae

Stagmatophora (H-Sch. Schmet. Eur., v, p. 49), *argyrostrepta*, Meyr. P.L.S.N.S.W., 1897, p. 353. Triabunna (Goldfinch).

Gelechiadae

Megacraspedus selerotricha Meyr. P.L.S.N.S.W., 1904, p. 279. Hobart.

Phthorimaea xerophylla Meyr. P.L.S.N.S.W., 1904, p. 320. Triabunna (Goldfinch).

Hemiarcha metableta Turn. Tr. R.S.S.A., p. 174. Mt. Wellington (2500 ft.).

Protolechia hormodes Meyr. P.L.S.N.S.W., 1904, p. 363. Hobart.

Xyloryctidae

Xyloryeta calligramma Meyr. Tr. R.S.S.A., 1890, p. 64. Hobart (Pearse).

Oecophoridae

Macrobathra anacampta Meyr. Exot. Micro., i, p. 217. Derby.

Artiastis ptochopa Meyr. P.L.S.N.S.W., 1888, p. 1675. Campbell Town.

Borkhausenia hypochalcha Meyr. P.L.S.N.S.W., 1888, p. 782. Hobart, Swansea, St. Marys, Launceston.

Borkhausenia aleurota Meyr. P.L.S.N.S.W., 1885, p. 799. Campbell Town, St. Helens, Launceston, Deloraine.

Barea exarcha Meyr. P.L.S.N.S.W., 1883, p. 357. Burnie.

Eulechria griseola Zel. Lin. Ent., x, p. 151. Meyr., P.L.S.N.S.W., 1882, p. 512. Scottsdale.

Eulechria myriospila Low. Tr. R.S.S.A., 1903, p. 168. Hobart, Mt. Wellington (1500-2500 ft.), Russell Falls, Bothwell, St. Marys, Derwent Bridge, Rosebery. Generally distributed

Eulechria cremnodes Meyr. P.L.S.N.S.W., 1882, p. 154. Derby.

Eulechria convictella Wlk., xxix, p. 566. Meyr., P.L.S.N.S.W., 1882, p. 518. Hobart.

Machimia absumptella Wlk., xxix, p. 567. Meyr., P.L.S.N.S.W., 1882, p. 505. Launceston.

Machimia pudica Zel. Lin. Ent., x, p. 152. Meyr., P.L.S.N.S.W., 1882, p. 500. Hobart.

Machimia carnea Zel. Lin. Ent., x, p. 148. Meyr., P.L.S.N.S.W., 1882, p. 498. Derwent Bridge (Goldfinch).

Thalerotricha mesoplaca Turn. (description will appear in P.L.S.-N.S.W). Mt. Wellington.

Orthiastis Meyr. (Exot. Micro., i, p. 247), *hyperocha* Meyr., P.L.S.-N.S.W., 1884, p. 744. Derwent Bridge.

Coesyra monodyas Meyr. P.L.S.N.S.W., 1884, p. 1047. Cradle Mountain (3000 ft.).

Oxythecta hieroglyphica Meyr. P.L.S.N.S.W., 1884, p. 1052. Coles Bay (Goldfinch).

Pyrgoptila zelotis Meyr., 1902, p. 143. Launceston (A. Simpson). By some mistake attributed to Queensland.

Philobota orthomita Turn. Tr.R.S.S.A., 1917, p. 88. Hobart

Philobota xanthiella Wlk., xxix, p. 693. Meyr., P.L.S.N.S.W., 1883, p. 505. Hobart.

Philobota electrodes Meyr. P.L.S.N.S.W., 1883, p. 512. Hobart (Pearse).

Compsotropha selenias Meyr. P.L.S.N.S.W., 1883, p. 512. Hobart (Pearse).

Eupselia aristonica Meyr. P.L.S.N.S.W., 1880, p. 218. Mt. Wellington (2500 ft.), Cradle Mountain (3000 ft.).

Thudaca mimodora Meyr., 1892, p. 574. Derwent Bridge.

Hyponomeutidae

Zelleria cynetica Meyr. P.L.S.N.S.W., 1892, p. 582. Hobart, St. Helens, Launceston, Deloraine.

Tanaoctena ooptila Turn. P.L.S.N.S.W., 1913, p. 205. Waratah.

Carposinidae

Paratheta aquilana Meyr. P.L.S.N.S.W., 1881, p. 697. Hobart.

Erechthiadae

Opogona nebularis Meyr. P.L.S.N.S.W., 1897, p. 420. Scottsdale.

Tineidae

Mimoscopa ochetaula Meyr. P.L.S.N.S.W., 1892, p. 526. St. Helens (Goldfinch).

Tinea pellionella Lin. Syst. Ent., i, p. 536. Meyr., P.L.S.N.S.W., 1892, p. 535. Hobart (introduced).

Hepialidae

A revision of the Australian genera and species (not yet completed), by Mr. N. B. Tindale, published in the records of the South Australian Museum (1932, 1933, 1935) has greatly added to our

knowledge of this family. Many new species have been described, and many changes in the nomenclature have been found necessary. Accordingly, I give here a complete list of the known Tasmanian genera and species.

Trictena Meyr. P.L.S.N.S.W., 1889, p. 1135.
argentata H-Sch. *(labyrinthica).* Lep. Exot, 1853, pl. xi, f. 47, 48. Hobart, Launceston.

Abantiades H-Sch. *(Pielus).* Lep. Exot., i, 1855.
hyalinatus H-Sch. Lep. Exot., i, 1853, pl. xi, f. 50. Hobart, Tasman Peninsula, Launceston.
labyrinthicus Don. Ins. New Hol., 1805, Pl. 38, f. 1. Launceston.
latipennis Tind. Rec. S.A. Mus., 1932, p. 530. Tasman Peninsula, Mt. Wellington (2500 ft.), Derwent Bridge, Zeehan, Launceston, Lake Fenton (3000 ft.).

Oncopera Wlk., vii., p. 1558.
**intricata*[1] Wilk., vii., 1559. Hobart, Maria Island, Swansea, Bothwell, Scottsdale, Cradle Mountain (2000 ft.), Launceston, Wilmot. Generally distributed.
rufobrunnea Tind. Rec. S.A. Mus., 1933, p. 23. Hobart, Fitzgerald, Maria Island, Derwent Bridge, Cradoc.

Jeana Tind. Rec. S.A. Mus., 1935, p. 279.
Two new species are here described.

Oxycanus Wlk., vii, 1573 *(Porina).*
australis Wlk., vii, p. 1574. Launceston, Longford, Sheffield, Maitland, Devonport.
fuscomaculatus Wlk., vii, p. 1574. Hobart, Launceston, George Town, Lefroy, Piper's River.
sordidus H-Sch. Lep. Exot., Pl. 11, f. 49. Hobart, Tasman Peninsula, Launceston.
subvarius Wlk., vii, p. 1562. Ulverstone.
**sphragidias* Meyr. P.L.S.N.S.W., 1889, p. 1123. Launceston, Maitland, Ulverstone, Arthur River, Blackman's Bay.

Fraüs Wlk., vii, p. 1561. *Hectomancs* Meyr. P.L.S.N.S.W., 1889, p. 1125.
simulans Wlk., vii, p. 1564. Hobart, Ross, Launceston.
rufula Turn. P.R.S.Tas., 1926, p. 163. Hobart, Launceston.
pteromela Low. Tr.R.S.S.A., 1892, p. 5. Hobart, Dunalley, Maria Island, Launceston.
**pelagia* Turn. P.R.S.Tas., 1926, p. 164. Strahan.

Charagia Walk., vii, p. 1569.
lignivora Lewin. Prod. Ent., p. 17, Pl. 16. Meyr. P.L.S.-N.S.W., 1889, p. 1129. Hobart, Beaconsfield.

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(1) Species marked with an asterisk have been recorded only from Tasmania.

Descriptions of New Species.

Family LARENTIADAE

Microdes leptobrya, n. sp.

λεπτοβρυος, slightly mossy.

♂ ♀. 25-30 mm. Head, ochreous-whitish more or less suffused with green and with a few dark fuscous scales. Palpi 3; grey, sprinkled with dark fuscous. Antennae, fuscous; in male, minutely ciliated. Thorax, fuscous, with some green and whitish scales. Abdomen, fuscous; dorsum with whitish transverse bars posteriorly. Legs, fuscous, with whitish rings; posterior pair paler. Forewings triangular, costa moderately arched, apex round-pointed, termen straight to near tornus, scarcely oblique; fuscous, with fine dark fuscous and broader ill-defined whitish-tinged greenish transverse lines; a moderate basal patch limited by a broad green-whitish line, which is strongly outwardly curved; this is edged with dark fuscous and followed by two dark fuscous lines, between which is the dark fuscous discal dot; postmedian line broad, green-whitish, narrowly edged with dark fuscous, from two-thirds costa obliquely outwards, obtusely angled above and below middle, thence curved to before tornus, sometimes interrupted by dark fuscous in middle; a fine sharply defined dentate whitish subterminal line; apices of teeth connected by dark lines with termen; an interrupted dark terminal line; cilia grey, apices whitish, strongly barred with fuscous. Hindwings with termen somewhat produced in middle; whitish-grey; a grey discal dot; a grey terminal band containing a pale dentate line; cilia grey, apices paler.

Waratah, in February; three specimens.

Microdes phricocrossa, n. sp.

φρικοκροσσος, with rippled edge.

♂ 32 mm. ♀ 36 mm. Head, pale grey; face, whitish. Palpi, in male, 2½, in female, 3; dark fuscous, extreme base and apex of second joint and apex of terminal joint, whitish. Antennae, grey; in male dentate and minutely ciliated. Thorax, pale grey; tegulae, whitish with base and subapical bar dark fuscous. Abdomen, grey-whitish. Legs, dark fuscous with whitish rings; posterior pair mostly whitish. Forewings, broadly triangular in male, narrower in female; costa, strongly arched to ¼, thence slightly; apex, rounded-rectangular; termen, slightly rounded, scarcely oblique; 5 from middle of cell or slightly below, whitish with some pale ochreous mottling and sparsely sprinkled with fuscous; markings, dark fuscous; a subcostal linear mark near base; an oblique line from ¼ costa, with a rounded rectangular bend above middle, partly double, ending on dorsum; an imperfect dentate median line; postmedian at ⅔, rounded and rippled, not angled, often resolved into

a series of dots on veins, succeeded by a fine whitish line or series of dots, sinuate towards dorsum; a dentate whitish terminal line, preceded and followed by fine longtitudinal streaks on veins; cilia, grey-whitish with narrow dark fuscous bars. Hindwings, with termen strongly rounded; pale grey; an irregular postmedian line of fuscous dots; an irregular whitish subterminal line; cilia as forewings.

Mt. Wellington and Waratah, in February; five specimens received from Mr. G. M. Goldfinch, who has the type.

The genus *Microdes* is confined to Australia and its adjacent island. It contains 10 described species, of which 7 (excluding *M. typhopa*, whose Tasmanian record is doubtful) are found in Tasmania, and of these 5 are peculiar to the island.

Larentia erasta, n. sp.

ἐραστος, charming.

♀. 38 mm. Head and thorax, bright green; apices of tegulae, fuscous. Palpi, 1½, fuscous, inferior edge ochreous-whitish. Antennae, pale fuscous obscurely annulated with whitish. Abdomen on dorsum, pale green with a double series of fuscous dots; lateral margins and underside, grey. Legs, ochreous-whitish sprinkled with fuscous; anterior pair, fuscous with whitish rings. Forewings, broadly triangular; costa, mostly straight, but gently arched near base and apex; apex, subrectangular; termen, slightly rounded, slightly oblique, slightly crenulate, bright green; markings and some irroration dark fuscous, a small basal patch, containing a slender transverse line and bordered by a broader line bent at a right angle above middle and edged with whitish from ⅓ costa to ⅓ dorsum; space between this and median band, with some costal dots and two incomplete transverse lines, edged with whitish; median band broad, containing a number of irregularly waved transverse lines, its anterior margin, irregularly dentate and edged with whitish, from ⅓ costa to mid-dorsum; posterior margin with a small subcostal and a more prominent rectangular supra-median tooth, thence inwardly oblique until again angled to end on ⅔ dorsum, whitish-edged; posterior to this several slender whitish lines and some fuscous mottling; subterminal, whitish, crenulate; an interrupted terminal line; cilia, whitish. Hindwings, with termen strongly rounded, slightly dentate; whitish with a series of slender wavy transverse lines; terminal line and cilia as forewings.

This magnificent species is not near any found in Australia, and resembles *L. muscosata* Wlk. from New Zealand, but is considerably larger.

Waratah, in February; one specimen received from Mr. G. M. Goldfinch, who has the type.

Euphyia photographica, n. sp.

φωτογραφικος, like a photograph.

♂. 33-36 mm. Head and thorax, blackish sprinkled with whitish. Palpi, 2, blackish sprinkled with whitish, more whitish beneath. Antennae, blackish; ciliations, in male, $\frac{1}{3}$. Abdomen, fuscous mixed with whitish, paired, blackish segmental dots on dorsum. Legs, blackish; tibiae and tarsi with whitish rings; posterior pair sprinkled with whitish. Forewings, broadly triangular; costa, nearly straight to $\frac{3}{4}$, thence arched; apex, round-pointed; termen, slightly rounded, slightly oblique, blackish, in parts sprinkled with whitish; basal patch ill-defined; median band, mostly whitish in centre, defined by broad blackish lines; first from $\frac{1}{3}$ costa to $\frac{2}{5}$ dorsum, outwardly curved, wavy, partly edged with whitish anteriorly; second from before $\frac{2}{3}$ costa to $\frac{4}{5}$ dorsum, posteriorly white-edged, indented above middle, with a very strong posterior median tooth, more or less double; a subcostal discal dot in median band; a very fine white crenulate subterminal lines, more distinct on costa; a terminal series of blackish dots; cilia, fuscous, outer half barred with whitish. Hindwings, with termen strongly rounded, dark grey, finely suffused whitish postmedian and subterminal lines; cilia, fuscous; apices, whitish.

The appearance of the forewings, strongly patterned in shades of black and white, irresistibly suggests the name I have given to this species.

Cradle Mountain (3000 feet), in February; two specimens.

Family BOARMIADAE

Psilosticha mactaria Gn.

Lep. ix, p. 270. *Boarmia atycta* Turn. is a synonym.

Having taken on Mt. Wellington (2500 feet) a second example of this species in much fresher condition, I have thought it advisable to redescribe it.

♀. 44-46 mm. Head and thorax, white sprinkled with blackish. Antennae, grey-whitish with fine blackish annulations. Palpi, $1\frac{1}{2}$; white sprinkled with blackish. Abdomen, white sprinkled with blackish; small paired blackish segmental dots on dorsum. Legs, white; tibiae and tarsi with blackish rings; anterior pair mostly fuscous. Forewings, broadly triangular; costa, straight, except at extremities; apex, round-pointed; termen, moderately rounded, slightly oblique; 10 and 11 long-stalked, 10 anastomosing with 9; white with blackish markings and irroration, appearing whitish-grey; a sub-basal costal spot; an oblique transverse line at $\frac{1}{4}$, angled beneath costa, closely followed by a parallel dotted line; a similar fine crenulate median line from midcosta to $\frac{2}{3}$ dorsum, closely preceded by a subcostal discal dot; a third fine crenulate dotted line from $\frac{3}{4}$ costa joining median

line below middle; closely following this a suffused grey line; a dentate white subterminal line preceded and followed by a grey suffusion; a terminal series of dots; cilia, whitish-grey, bases barred with blackish. Hindwings, with termen slightly rounded, dentate; colour and markings as forewings, but lines, except subterminal, becoming undefined towards costa. Underside, whitish, sparsely sprinkled with fuscous; a blackish discal dot on each wing.

Casbia crataea, n. sp.

κραταιος, stout.

♂. 36 mm. Head, brown-whitish; face, fuscous. Palpi, 1; whitish-brown, bases of first and second segments, fuscous. Antennae, whitish-brown (pectinations 6 near base, remainder broken off). Thorax, whitish-brown mixed with fuscous; two dark fuscous posterior dots. Abdomen, brown-whitish with some fuscous irroration towards base of dorsum. Legs, whitish-brown marbled with fuscous. Forewings, broadly triangular; costa, strongly arched to ¾, thence straight; apex, rectangular; termen, rounded, slightly oblique crenulate; whitish-brown sprinkled with fuscous, more densely in median area, fuscous strigulae towards termen; basal area paler, edged by a broad outwardly-curved fuscous line from ¼ costa to ⅓ dorsum; a blackish median discal dot, immediately preceded by a fuscous line to mid-dorsum, not reaching costa; a tolerably straight fuscous line from costa before apex to ⅔ dorsum, immediately succeeded by a narrow whitish-brown shade, which is crossed by fine short, white streaks on veins 1, 2, 3, 4, each ending in a fuscous dot; cilia, fuscous. Hindwings with termen only slightly rounded: costal, half crenulate, brown-whitish, irroration and strigulae less dense than on forewings; a small blackish discal dot; antemedian and postmedian transverse lines, the latter succeeded by fine, short, white streaks on veins 2, 3, 4, 6, between them some reddish-brown scales, and at their apices fuscous dots; cilia, fuscous.

Larger and more stoutly built than *C. eccentritis*, distinguished by the peculiar postmedian markings and crenulate termen of both wings.

Strahan, in January; one specimen.

Casbia rhodosceles, n. sp.

ῥσδοσκελης, rosy-legged.

♂. 34-36 mm. Head, grey-whitish, more or less pinkish-tinged. Palpi, 1½, crimson mixed with whitish-ochreous. Antennae, grey; pectinations in male extremely long, only extreme apex simple. Thorax, grey; a pair of blackish dots close to its posterior apex. Abdomen, whitish-grey. Legs, whitish-ochreous sprinkled with dark fuscous; anterior coxae and anterior and middle femora, crimson.

similarly sprinkled; anterior and middle tibiae mostly fuscous. Forewings, broadly triangular; costa, straight, except near base and apex, apex, acute, termen, straight, rounded beneath, slightly oblique; 7, 8, 9, 10 stalked, 11 from cell anastomosing with 12 (3♂); grey-whitish, more or less suffused with grey; costal, edge strigulated with fuscous, often crimson towards base; three transverse fuscous lines, often partly reddish; first at ¼, outwardly curved, dentate; second median, slightly curved, rather suffused; third at ¾, sinuate, suffused or dentate; a dark fuscous subcostal discal dot on second line; a dentate fuscous subterminal line more or less developed, preceded by two whitish dots about middle, curved inwards above dorsum; a terminal series of dark fuscous dots; cilia, grey, sometimes pinkish-tinged, sometimes with a basal series of whitish dots. Hindwings with apex rectangular; termen, nearly straight, slightly crenulate; pale grey with fine whitish strigulae: a median fuscous discal dot; terminal dots and cilia, as forewings.

Mt. Wellington, in February; three specimens.

Family NOLIDAE

Gen. **Nestiodes**, nov.

νηστιωδης, apparently fasting.

Tongue, absent. Palpi, short, porrect, obtuse. Forewings, with 2 from ¾, 3 from angle, 4 from shortly above angle, 5 from below middle of cell, 6 from upper angle, 9 absent, 7, 8, 10 stalked, 7 separating before 10. Hindwings, with 4 absent, 6 and 7 stalked, 12 anastomosing with cell to beyond middle.

A development of *Nola*, from which it differs in the short palpi and absence of tongue.

Nestiodes eremnopa, n. sp.

ἐρεμνωπος, like a fortification.

♂♀. 17 mm. Head and thorax, white with some dark fuscous scales. Palpi, 1; grey or whitish. Antennae, whitish-grey; in male evenly ciliated, ciliations in male ½. Abdomen, whitish. Legs, whitish sprinkled with fuscous. Forewings, triangular; costa, straight to ¾, thence arched; apex, obtusely pointed; termen, nearly straight, oblique; white; markings and some irroration dark fuscous; two or three sub-basal tufts towards costa; a sub-dorsal dot at ⅓, from which an interrupted line angled outwardly runs to ¾ costa; two nearly parallel fine dentate lines, first from mid-dorsum to costa, second from mid-costa to dorsum. in the male the intermediate space is filled with irroration to form a fascia; a subterminal fascia strongly indented above middle, narrowed into a slender line before

ending on tornus; a white line edges this posteriorly; a terminal line thickened into small apical and subapical blotches; cilia, fuscous. Hindwing and cilia, pale grey.

Mt. Wellington (2500 feet), in February, also from Ebor (4000 feet), New South Wales, in January. My type is the female from Ebor.

Nola plagioschema, n. sp.

πλαγιοσχημος, with oblique pattern.

♂. 20 mm. Head and thorax, white. Palpi, 4, laterally compressed, with rough projecting scales beneath; upper edge and inner surface whitish, outer surface fuscous. Antennae, grey; in male with tufts of moderately long cilia (1½). Abdomen, pale grey; tuft, grey-whitish. Legs, whitish; anterior pair, fuscous with whitish tarsal rings. Forewings, elongate-triangular; costa, slightly arched; apex, pointed; termen, nearly straight, oblique, fuscous largely suffused with whitish; a lark fuscous tuft beneath costa near base; a slender dark fuscous line from midcosta to ¼ dorsum, sharply angled inwards and then outwards near dorsum, with two tufts of raised scales beneath costa; a second line from ¾ costa to ⅔ dorsum, similar but almost straight, white-edged posteriorly, angled inwards just above dorsum; a series of short, dark fuscous longitudinal streaks forming a slightly inwardly-curved line from apex to tornus; cilia, fuscous with whitish bars. Hindwings and cilia, pale grey.

Russell Falls and Waratah, in February; two specimens.

Family NOCTUIDAE

Dasygaster eutycta, n. sp.

εὐτυκτος, well-wrought.

♂. 38 mm. Head and thorax, fuscous. Palpi, 1½; second joint ascending, densely rough-scaled; terminal joint short, porrect, obtuse; fuscous, terminal joint, apex of second joint, and inner surface whitish. Antennae, grey-whitish; in male shortly bipectinate (1) with lateral and terminal ciliations. Abdomen, fuscous; basal and terminal segments grey on dorsum. Legs, fuscous; tarsi and posterior pair paler. Forewings, elongate-triangular; costa, straight; apex, obtusely pointed; termen, slightly rounded, slightly oblique, fuscous; markings, blackish, partly outlined with whitish; a median basal spot; a pait of costal dots near base; a sub-basal dorsal spot; a slender whitish line from ¼ costa to mid-dorsum, with an anterior tooth above dorsum, preceded and followed by a costal dot; a spot touching middle of this line, followed by a narrow white loop representing claviform; orbicular, circular, white-ringed; reniform, similar, but transversely oblong; a slender whitish line from ⅔ costa to ¾ dorsum, preceded by a series of triangular dots, that

above dorsum larger and produced to claviform; a terminal series of elongate spots; cilia, whitish. Hindwings with termen gently rounded, grey; cilia, whitish.

Coles Bay, in February; one specimen received from Mr. G. M. Goldfinch, who has the type.

Dasygaster eudmeta, n. sp.

εὐδμητος, well fashioned.

♂♀. 34-40 mm. Head, fuscous, more or less sprinkled with white. Palpi, 2, fuscous, anteriorly brown-whitish. Antennae, fuscous; in male with fascicles of cilia (1). Thorax, white, mixed with fuscous; two anterior fuscous lines sometimes followed by a brown line; dark fuscous submarginal lines on tegulae. Abdomen, grey. Legs, grey; anterior and middle tarsi, fuscous with white rings. Forewings, narrowly triangular; costa, straight; apex, rounded; termen, slightly rounded, scarcely oblique; white, mostly suffused with grey, and sometimes partly with brownish; median area darker; lines blackish; a median streak from base to ⅓; a strigula from costa near base; a very strongly dentate line from ¼ costa to ⅜ dorsum, orbicular narrow, obliquely elongate, white with grey centre; reniform similar, but broadly oval and transverse; postmedian line from ⅔ costa obliquely outwards, sharply bent beneath costa, thence sharply dentate and excavated above and beneath middle, ending on ⅔ dorsum; a broad pale shade from apex to tornus, distinctly outlined, with two strong teeth below middle reaching termen; a terminal series of small fuscous lunules; cilia, fuscous with narrow white bars. Hindwings, with termen wavy, dark grey; cilia, white with grey basal line.

Waratah, in February; plentiful at light.

Caradrina metableta, n. sp.

μεταβλητος, variable.

♂♀. 32-36 mm. Head and thorax, fuscous-grey, sometimes brownish-tinged. Palpi, 1½, fuscous; terminal joint and apex and lower edge of second joint brown-whitish. Antennae, grey or fuscous, often paler towards base; in male with fascicles of cilia (1). Abdomen, grey. Legs, fuscous-grey or brownish-grey with pale rings. Forewings, narrowly triangular; costa, almost straight; apex, rounded; termen, straight, rounded beneath, not oblique; grey or fuscous in female usually brownish; in male usually a fine blackish median streak from base, but this is absent in female; a very fine dentate fuscous line from ⅓ costa to ⅜ dorsum, often obsolete; orbicular and reniform, ochreous-whitish, the former circular, minute, the latter usually quadrangular with a slight process at posterior inferior angle, sometimes partly bisected by a dark

streak from inferior edge; a fine fuscous line from $\frac{2}{3}$ costa, outwardly oblique, then bent downwards beyond reniform, and dentate to $\frac{2}{3}$ dorsum, often obsolete; a dark subterminal shade, its posterior edge wavy and well defined, sometimes partly dark fuscous or containing some longitudinal dark streaks above middle, sometimes a fine interrupted fuscous terminal line; cilia, grey, bases sometimes ochreous-whitish. Hindwings, with termen rounded, grey; cilia, grey.

Apparently nearest *C. tortisigna* Wlk., but without pale costal streak and terminal band.

Waratah, in February; plentiful at light.

Hypenodes capnophanes, n. sp.

καπνοφανης, dusky.

♂. 16-18 mm. Head, thorax, abdomen, and legs, fuscous. Palpi, with second joint extremely long, porrect, thickened with scales throughout, slightly rough above and beneath; terminal joint short, obliquely ascending, acute, fuscous. Antennae, fuscous; ciliations in male 1½. Forewings, narrowly triangular; costa, slightly arched near base, thence straight to near apex, where it is again arched; apex, pointed; termen, sinuate, slightly oblique, dark fuscous; markings, white; three or four minute dots on apical ¼ of costa; an oblique line from beneath $\frac{3}{4}$ costa to $\frac{2}{3}$ dorsum, interrupted below middle; the upper portion preceded by a blackish suffusion; a very fine sinuate subterminal line not reaching costa; cilia, fuscous. Hindwings, broad; termen, sinuate, grey; cilia, grey.

Vein 9 is absent in the forewing. In this it differs from Meyrick's definition (Revision Handbook. Brit. Lep., p. 165), but this figure of *H. costistrigalis* Steph. shows that this vein separates very near margin. Hampson (Moths Ind. III, p. 98) describes a species from Ceylon with 9 absent.

Mt. Wellington (1500-2500 feet), in January and February; two specimens.

Family CRAMBIDAE

Platytes platysticha, n. sp.

πλατυστιχος, broad-lined.

♂. 23 mm. Head, ochreous-whitish. Labial papli, 5, fuscous. Maxillary palpi, whitish. Antennae, fuscous; ciliations in male minute. Thorax, ochreous-whitish; tegulae and underside, fuscous; pectus, whitish. (Abdomen missing.) Legs, ochreous-whitish; anterior pair, fuscous anteriorly. Forewings, narrow, posteriorly dilated; costa, straight to $\frac{2}{3}$, thence gently arched; apex round-pointed; termen, slightly oblique, ochreous-whitish with fuscous longitudinal streaks; a narrow costal streak to $\frac{2}{3}$; a broad streak along fold to middle; a median streak commencing as a fine line at

½, soon broadening and continued to costa, just before apex, its apical portion divided into three fine parallel lines; five short interneural streaks between this and dorsum; a series of six elongate interneural marks running into termen, the five lower connected with the preceding streaks by fine irroration; cilia, whitish with a broad, grey sub-basal line. Hindwings and cilia, whitish.

Russell Falls, in February; one specimen received from Mr. G. M. Goldfinch, who has the type.

Family TORTICIDAE

Capua euryphaea, n. sp.

εὐρυφαιος, broadly fuscous.

♀. 14 mm. Head, ochreous-whitish. Palpi, 2, whitish, lower edge, fuscous. Antennae, fuscous. Thorax, ochreous-whitish with some fuscous scales. (Abdomen missing.) Legs, fuscous with whitish rings; posterior pair whitish. Forewings, moderately dilated; costa, slightly arched; apex, rounded-rectangular; termen, slightly oblique, ochreous-whitish; markings, dark fuscous, sharply defined; several costal strigulae; a broad basal dorsal blotch reaching more than half across disc, confluent with middle of median fascia, which is narrow on ⅔ costa, but broadens to extend almost to tornus, leaving a white spot on dorsum between it and dorsal blotch; a costal triangle from middle to ⅘; some fuscous irroration on termen; cilia, ochreous-whitish, towards apex mixed with fuscouse. Hindwings, pale grey; cilia, whitish.

Scottsdale, in January; one specimen.

Capua ochrobaphes, n. sp.

ὠχροβαφης, pale.

♂. 13 mm. Head and thorax, ochreous-whitish. Palpi, 1¾, ochreous-whitish, lower edge, fuscous. Antennae, pale grey; ciliations in male, ½. Abdomen, grey; tuft, grey-whitish. Legs, fuscous with whitish rings; posterior pair mostly whitish. Forewings, slightly dilated; costa rather strongly arched; apex, subrectangular; termen, slightly oblique, ochreous-whitish; costa, with short, fuscous strigulae, a suffused fuscous streak, broad at base, from costa near apex curved inwards above middle of disc and extended longitudinally to before ½; an incomplete submarginal line of minute fuscous dots; cilia, ochreous-whitish, bases, except at tornus, fuscous. Hindwings, pale grey; cilia, whitish with a pale grey sub-basal line.

Burnie, in February; one specimen.

Tortrix adoxodes, n. sp.

ἀδοξωδης, obscure.

♂. 14-16 mm. Head and thorax, dark fuscous, more or less sprinkled with reddish. Palpi, 1½, brownish. Antennae, fuscous; in male with tufts of rather long cilia (1½). Abdomen, dark fuscous. Legs, fuscous with whitish tarsal rings. Forewings, sub-oblong; costa moderately arched; apex, rectangular; termen, straight, scarcely oblique; in male a narrow costal fold reaching ⅓, its posterior portion dilated by long whitish scales; dark fuscous with patchy reddish irroration; markings, indefinite, consisting mainly of obscure transverse darker and lighter striae; three whitish striae on midcosta coalescing to form a short ill-defined very oblique pale streak; cilia, fuscous. Hindwings and cilia, fuscous.

Waratah, in February; five specimens.

Tortrix phaeosticha, n. sp.

φαιοστιχος, with dark streaks.

♂ ♀. 18-23 mm. Head and thorax, reddish-brown. Palpi, 2½, brownish. Antennae, pale ochreous-brown; ciliations in male 1. Abdomen, pale grey. Legs, reddish-fuscous; posterior pair mostly whitish. Forewings, sub-oblong; costa, strongly arched, especially towards base; apex, rectangular; termen, faintly sinuate, rounded beneath; in male with a very narrow fold reaching to ⅔; pale ochreous, margins and most veins usually reddish-fuscous; a conspicuous boomerang-curved streak from base along upper margin of cell; a broad dorsal streak containing some paler suffusion; fold and a narrow costal patch from middle to near apex, dark; more or less dark suffusion on terminal area, but veins always darker, subcostal and central areas, together with continuation to apex, pale; cilia, whitish with a fine fuscous sub-basal line. Hindwings, pale grey with faintly darker strigulae; cilia, grey-whitish.

In coloration this approaches *T. postvittana*, but is very distinct in pattern from any of the variations of that species.

Mt. Wellington, St. Helens, Wilmot, Waratah, Rosebery, Strahan, and Weldborough, in January and February; eleven specimens.

Tortrix technica, n. sp.

τεχνικος, artistic.

♂ ♀. 16-20 mm. Head, white. Palpi, 1¾, fuscous. Antennae, fuscous; ciliations in male, ⅔. Thorax, fuscous with a white anterior spot. Abdomen, pale grey; tuft, whitish. Legs, fuscous; posterior pair, whitish. Forewings, sub-oblong; costa, strongly arched in basal half, thence nearly straight; apex, obtusely angled; termen, straight, oblique, rounded beneath; in male with a very narrow costal fold

reaching to $\frac{1}{3}$, a small triangular tuft of scales on its apical portion; white with some pale grey suffusion towards base and dorsum; markings, dark fuscous, sharply outlined; two short, broad streaks from base, the upper reaching a broad line from costa near base to $\frac{1}{3}$ dorsum; an outwardly-oblique line from $\frac{1}{3}$ costa, sharply angled in mid-disc and continued to termen beneath apex, there expanded and connected by two fine lines to apex and costa shortly before; an irregular blotch on dorsum before tornus, sometimes connected with previous line; cilia, white, sometimes partly grey beneath apex. Hindwings, pale grey; cilia, whitish.

Closely allied to *T. oriarcha* Meyr., from the Australian Alps.

Waratah, in January and February; locally abundant.

Tortrix oresigona, n. sp.

ὀρεσιγονος, mountain-born.

♂. 18-20 mm. Head, fuscous. Palpi, 2, fuscous. Antennae, fuscous; in male with tufts of moderately long cilia (1). Thorax, fuscous, sometimes with a few whitish scales. Abdomen, grey; tuft, paler. Legs, fuscous with whitish rings; posterior pair, whitish-grey. Forewings, sub-oblong; costa, moderately arched to middle, thence straight; apex, obtusely angled; termen, straight, slightly oblique; whitish suffused with pale grey; markings, dark grey edged with fuscous; a moderate basal patch, containing some whitish scales, near base, its outer edge from $\frac{1}{5}$ costa to fold, where it is bent outwards, thence downwards to $\frac{1}{3}$ dorsum; central fascia, oblique from well before middle, ceasing abruptly in mid-disc, there enlarged and produced upwards to approach or joint costal patch, which is narrow and extends from $\frac{3}{5}$ costa nearly to apex; a broad, triangular tornal patch; a circular spot on midtermen, sometimes touching dorsal patch, or prolonged on termen to apex; cilia, fuscous. Hindwings, with termen sinuate, grey with some darker striae; cilia, grey-whitish with a darker basal line.

Nearest *T. euraphodes* Turn., from Mt. Kosciusko.

Mt. Wellington (4000 feet), in January; locally common.

Tortrix campylosticha, n. sp.

καμπυλοστιχος, with bent lines.

♂ ♀. 20-22 mm. Head, pale ochreous or whitish. Palpi, $2\frac{1}{4}$, fuscous, upper edge pale ochreous or whitish. Thorax, dark fuscous with a postmedian white transverse line. Abdomen, ochreous, towards base grey. Legs, fuscous; posterior pair, ochreous. Forewings, sub-oblong; costa, arched to middle, thence straight; apex, obtusely angled; termen straight, slightly oblique; in male without coastal fold; white with dark fuscous angular fuscous lines and marginal dots; a rather broad sub-basal line; another from $\frac{1}{5}$ costa

to ¾ dorsum, angled outwards in middle, and inwards below this, rarely interrupted; a third from before midcosta, often constricted or interrupted above middle, angled outwards beneath costa, often incomplete or divided above dorsum, on which it may be represented by one or two dots; costal dots between this and following lines; an oblique line from ⅔ costa to termen below middle, usually bifurcate on costa; an irregular erect line from tornus; a terminal series of confluent dots; cilia, white, bases suffused or barred with fuscous. Hindwings and cilia, ochreous.

This is the Tasmanian representative of *T. amoenana* Meyr., but it appears sufficiently distinct for specific separation.

Cradle Mountain (2000-3000 feet), Waratah, and Derwent Bridge, in January and February; locally common.

Tortrix haplopolia, n. sp.

ἁπλοπολιος, simple grey.

♂. 18-20 mm. Head and thorax, grey. Palpi, 2, grey. Antennae, grey, annulated with blackish; ciliations in male (1), Abdomen, pale grey; tuft, whitish. Legs, whitish; anterior pair, fuscous. Forewings, sub-oblong; costa, strongly arched; apex, rectangular; termen, straight, rounded beneath, scarcely oblique; in male with a very narrow rudimentary costal fold to about middle; grey with numerous fine fuscous strigulae tending to form wavy transverse lines; cilia, grey. Hindwings, with termen sinuate, whitish coarsely strigulated with grey; cilia, pale grey.

Mt. Wellington (2500 feet) and Waratah, in February; six specimens.

Tortrix flebilis, n. sp.

flebilis, mournful.

♂. 16-20 mm. Head, grey. Palpi, 2, fuscous, inner surface and upper edge whitish. Antennae, grey; ciliations in male (1). Thorax, fuscous. Abdomen, grey. Legs, fuscous; posterior pair whitish. Forewings somewhat dilated posteriorly; costa, strongly arched to ⅓, thence straight; apex, pointed; termen, straight, oblique; in male without costal fold; fuscous more or less sprinkled with reddish; sometimes a broad whitish streak strigulated with reddish and grey on dorsum and continued round tornus (in two examples), but this is usually completely absent; no defined markings, but usually a darker oblique streak from middle of disc to tornus and ill-defined and variable longitudinal streaks in disc; cilia, white with a reddish or grey basal line. Hindwings, grey with obscure darker strigulae; cilia, white with grey basal line.

The form of variation is curious.

Waratah, in January and February; five specimens.

Tortrix leuropa, n. sp.

λευρωπος, smooth.

♂. 17 mm. ♀. 22 mm. Head and thorax, dark grey. Palpi, in male 2½, in female, 3, pale grey reddish-tinged. Antennae, grey; ciliations in male (1). Abdomen, whitish-grey. Legs, grey-whitish. Forewings, sub-oblong; costa, strongly arched, especially towards base; apex, subrectangular; termen, sinuate, slightly oblique; in male without costal fold; pale reddish-grey, in male with scattered blackish dots; an elongate mark on ¼ dorsum fuscous mixed with reddish; a variable fuscous or reddish patch on ¾ dorsum; two or three blackish dots on tornus; cilia, ochreous-whitish, reddish-tinged near apex of wing. Hindwings, pale grey with distinct darker strigulae; cilia, whitish.

Probably allied to *T. oressinoma* Turn.

Scottsdale, in January; two specimens.

Tortrix antilecta, n. sp.

ἀντιλεκτος, questionable.

♂. 18-20 mm. Head and thorax, grey. Palpi, 2, grey. Antennae, grey; ciliations in male ⅔. Abdomen, grey, tuft, ochreous-whitish. Legs, fuscous; posterior pair, ochreous-whitish. Forewings, sub-oblong, not dilated; costa, rather strongly arched; apex, rectangular; termen, straight, rounded beneath, hardly oblique; male with a very slender costal fold to ⅓, with a smaller triangular tuft of scales before its end; whitish-grey, more or less strigulated with darker grey, in some examples scantily sprinkled with pale ochreous in parts; markings, fuscous; a basal costal dot and tuft on costal fold, fuscous; sometimes a series of costal dots; a fine interrupted line from ⅔ costa to ¾ dorsum more or less developed; sometimes a short inwardly oblique line from ⅔ costa to mid-disc, but this is usually reduced to one or two dots, and may be wholly absent; cilia, grey-whitish. Hindwings and cilia, grey-whitish.

A variable species. In some examples the markings are much reduced, and in one completely absent.

Waratah, in January and February, Rosebery, in February; five specimens. Also two from Sydney, in October (G. M. Goldfinch). My type is from Waratah.

Arotrophora pantoeodes, n. sp.

παντοιωδης, variable.

Arotrophora castanea Turn. Proc. Roy. Soc. Tas., 1926, p. 132, nec Meyr.

Although I have not seen an authentic example of Meyrick's species, I am now satisfied that it is distinct from that which I have fully described.

Mt. Wellington (2500 feet), Lake Fenton, and Derwent Bridge. in January.

Family EUCOSMIDAE

Laspeyresia argyrocyrta, n. sp.

ἀργυροκυρτος, with silvery curve.

♀. 13 mm. Head, thorax, and abdomen, fuscous. Palpi, 2, whitish; terminal joint, except apex, fuscous. Antennae, fuscous. Legs, fuscous; posterior pair, paler. Forewings, sub-oblong; costa, gently arched; apex, rounded-rectangular; termen, nearly straight, slightly oblique, fuscous; a broad, oblique, outwardly-curved, white bar from mid-dorsum to middle of disc; costa with alternate dark fuscous and whitish streaks, metallic at apices, from ¼ almost to apex, dark streaks, all short, the first four outwardly oblique; first and second pale streaks short, each bisected on costa by a dark fuscous dot; third similarly bisected on costa, prolonged as an evenly curved metallic line to tornus, at first violet-metallic, then broadened and silvery; fourth short; fifth rather longer; sixth long, and bent outwards to touch apex of ninth, which is also long; seventh and eighth very short; four longitudinal black lines between lower half of termen and third streak; cilia, fuscous. Hindwings and cilia, fuscous.

There are several nearly allied Australian species.

Tasman Peninsula, in January; one specimen.

Family ELACHISTIDAE

Labdia apenthes, n. sp.

ἀπενθης, cheerful.

♂. 9 mm. Head, white. Palpi, white; both second and third terminal joints with basal and subapical blackish rings. Antennae, blackish with white annulations. Thorax, dark fuscous. Abdomen, fuscous; tuft, grey-whitish. Legs, fuscous with white rings. Forewings, narrow; apex, rounded; a small grey basal patch with blackish median and dorsal marginal dots; white costal spots at ¼, ½, and ¾; between these blackish costal spots at ⅓ and ⅔, and another at apex; dorsal area, grey; a triangular blackish median spot nearly touching apex of first blackish spot on costa; a white line from tornus nearly reaching third white costal spot; cilia, whitish-ochreous, on dorsum, grey. Hindwings, linear-lanceolate, grey; cilia, 5, grey.

Allied to *L. niphostephes* Turn., from which it may be best distinguished by the fuscous thorax.

Hobart, in January; one specimen received from Capt. D. C. Pearse.

Labdia auchmerodes, n. sp.

αὐμηρωδης, dusty.

♀. 10 mm. Head, thorax, and abdomen, grey. Palpi, blackish, second joint with basal and median, terminal joint with basal, median, and subapical white rings. Antennae, grey. Legs, dark

fuscous with white rings. Forewings, narrow; apex, round-pointed, whitish-grey; markings, fuscous, not sharply defined; three dots in an oblique line, first on costa near base, second above fold, third between fold and $\frac{1}{3}$ dorsum; two transverse fasciae at $\frac{1}{4}$ and middle; a fine median streak from $\frac{3}{4}$ to apex; cilia, grey. Hindwings, narrow-lanceolate; cilia, 5, grey; cilia, grey.

Hobart, in January; one specimen.

Trachydora oxypeuces, n. sp.

ὀξυπενκης, sharp-pointed.

♂. 24 mm. Head, grey-whitish. Palpi, with second joint dilated at apex forming a short triangular anterior tuft, grey; terminal joint whitish with three fuscous rings. Antennae, grey. Thorax, grey-whitish, anterior and lateral margins blackish. Abdomen, grey; dorsum of second and third segments brownish with fuscous median line. Legs, pale grey. Forewings, lanceolate; apex, acute; grey-whitish with blackish longitudinal line and some irroration towards costa; a fine subcostal streak from base to $\frac{1}{4}$, a median streak from base to apex, thickened in middle portion, slender towards each end; beneath this a narrow grey suffusion; a line along fold to middle bearing several prominent crests; a white apical dot; cilia, grey. Hindwings, narrow-lanceolate, grey; cilia, grey.

Rosebery, in January; one specimen.

Microcolona polygethes, n. sp.

πολυγηθης, delightful.

♂. 10 mm. Head and thorax, grey. Palpi, white with three blackish rings, apical on second joint, sub-basal and subapical on terminal joint. Antennae, white annulated with blackish. (Abdomen missing.) Legs, grey on dorsal, white on ventral surface. Forewings, narrow; grey suffused with pale ochreous, except on costal margin; markings, black; a minute dot on fold near base; first discal at $\frac{2}{5}$, white-edged, plical beneath it, larger, second discal at $\frac{4}{5}$, crescentic or double; a series of minute dots on apical third of costa and on termen; cilia, fuscous, on dorsum, grey. Hindwings, linear-lanceolate, grey; cilia, 6, grey.

Tasman Peninsula, in January; one specimen.

Batrachedra notocapna, n. sp.

νωτοκαπνος, smoky-backed.

♀. 14 mm. Head, white; centre of crown whitish-grey. Palpi with slight angular projection on apex of second joint; white, median, and subapical rings on second joint and one on apex of terminal joint, blackish. Antennae, grey. Thorax, whitish-grey in centre, broadly white on sides. Abdomen and legs, whitish. Forewings very

narrow; apex, acute, white, sparsely but fairly uniformly sprinkled with fuscous; a rather broad but not distinctly defined dorsal fuscous streak from base, gradually attenuating to about $\frac{2}{3}$; cilia, pale grey. Hindwings, linear-lanceolate, pale grey; cilia, 6, pale grey.

Hobart, in January; one specimen received from Capt. D. C. Pearse.

Scythris albipuncta, n. sp.

albipunctus, with white dots.

♂. 12 mm. Head, palpi, thorax, and abdomen, dark fuscous with bronzy reflections. Antennae, fuscous; in male shortly ciliated ($\frac{1}{2}$). Legs, fuscous. Forewings, narrow; apex, rounded, dark fuscous with bronzy reflections; stigmata, white, minute, first discal at $\frac{2}{5}$, plical slightly beyond it, second discal at $\frac{2}{3}$; a white spot on tornus; a white subapical dot; cilia, fuscous, on dorsum, grey. Hindwings, narrow lanceolate, cilia, 6, both grey.

Burnie, in January; one specimen.

Fam. GELECHIADAE

Iulota ochropolia, n. sp.

ὠχροπολιος, pale grey.

♀. 12 mm. Head and thorax, pale grey. Palpi, grey; apex of terminal joint whitish. Antennae. whitish annulated with dark fuscous. (Abdomen missing). Legs, grey-whitish; posterior pair, white. Forewings, lanceolate, whitish finely sprinkled with pale grey; cilia, whitish, on apex, grey. Hindwings and cilia, pale grey.

Allied to *I. phauloptila* Turn. from Mt. Kosciusko.

Strahan, in January; one specimen.

Aristotelia aphthoropa, n. sp.

αφθορωπος, chaste.

♂. 12-13 mm. Head, thorax, and abdomen, grey-whitish. Palpi, with second joint reaching base of antennae, rough anteriorly, terminal joint $\frac{2}{3}$, grey-whitish; apex of terminal joint whitish. Antennae, grey-whitish; ciliations of male minute. Legs, whitish. Forewings, narrow; apex, acute; termen extremely oblique, grey-whitish; a few fuscous scales at apex; cilia, whitish. Hindwings with apex acute; termen strongly sinuate, whitish; cilia, whitish.

Strahan, in January; two specimens.

Gen. **Idiozancla**, nov.

ἰδιοξαγκλος, with peculiar sickles.

Tongue present. Palpi, with second joint extremely long, very much thickened with smoothly oppressed scales, a loose posterior tuft of long scales at apex, terminal joint short, slender, acute. Forewings with

2 and 3 stalked, 7 and 8 stalked, 7 to costal, 11 from well before middle. Hindwings about 1; apex round-pointed; termen not sinuate; 3 and 4 connate, 5 strongly curved and approximated to 4 at origin, 6 and 7 parallel.

A derivative of *Protolechia*, with peculiar palpi. Its relationship to *Ephelictis* is probably only collateral.

Idiozancla ignobilis, n. sp.

ignobilis, obscure.

♀. 16 mm. Head, grey-whitish. Palpi, with second joint more than three times length of face, greatly thickened, smooth, but with a strong posterior tuft of scales at apex; terminal joint very short ($\frac{1}{3}$), very slender, acute, brown sprinkled with fuscous. Antennae, grey. Thorax, pale brownish-fuscous. Abdomen, grey-whitish. Legs, fuscous-brown; posterior pair, grey-whitish. Forewings, narrow; costa strongly arched; apex rounded; termen very oblique, pale brownish-fuscous; a fuscous plical dot at $\frac{1}{3}$; cilia, grey. Hindwings, grey; cilia, whitish-grey.

Deloraine, in February; one specimen.

Protolechia platyzancla, n. sp.

πλατυξαγκλος, with broad sickles.

♂♀. 14-15 mm. Head, pale grey. Palpi with second joint reaching base of antennae; terminal joint $\frac{2}{3}$, stout, fuscous; inner surface of second joint, whitish. Antennae, grey. Thorax, grey, with a posterior whitish spot. Abdomen, whitish-grey; posterior half in male whitish-ochreous. Legs, grey; posterior pair, whitish. Forewings, narrow; costa, slightly arched; apex, rounded; termen, very oblique; 2 and 3 stalked; pale fuscous; a broad white costal streak from base not quite reaching apex, sprinkled with a few fuscous scales, inferior edge straight, not indented stigmata obscurely darker, minute; first discal at $\frac{1}{3}$, plical beyond it, second discal at $\frac{2}{3}$; cilia, fuscous. Hindwings, with termen sinuate, grey; cilia, grey.

Allied to *P. invalida* Meyr. and *P. euryarga* Turn., but differing in many details, and especially in the stout wholly fuscous terminal joints of palpi.

St. Marys, in January (female type). Also a male from Caloundra, Queensland.

Family XYLORYCTIDAE

Xylorycta polysticha, n. sp.

πολυστιχος, many-striped.

♀. 26 mm. Head and thorax, pale fuscous. (Palpi missing.) Antennae, grey. Abdomen, grey-whitish; bases of segments ferruginous-fuscous. Legs, fuscous; posterior pair, whitish. Forewings sub-oblong; costa, gently arched; apex rounded; termen somewhat obliquely rounded, pale ochreous, irrorated, and streaked with pale fuscous; markings, shining white; a moderate costal streak from base to $\frac{2}{3}$; three short, slender oblique streaks running to costa between this and apex; a broad median streak from base to end of cell at $\frac{2}{3}$, dilated in middle to contain an elongate dark spot, and ending on a fuscous discal dot, from which two fine parallel streaks run to termen, beneath these three similar streaks, a fine streak on fold and another broader on dorsum extended on termen to near apex; cilia, fuscous; apices, white. Hindwings, $1\frac{1}{2}$, pale grey; cilia, whitish.

Nearest, *X. calligramma* Meyr.

Derwent Bridge, in January; one specimen.

Xylorycta sucina, n. sp.

sucinus, amber-coloured.

♀. 34 mm. Head, grey. Palpi with second joint exceeding base of antennae, terminal joint $\frac{2}{3}$, fuscous, base and extreme apex of second joint and whole inner surface, white. Antennae, grey, paler towards base. Thorax, ochreous-brown. Abdomen, grey; apices of segments and tuft, ochreous-whitish. Legs, whitish-ochreous. Forewings, elongate, slightly dilated; costa, gently arched; apex, rounded-rectangular; termen, straight, slightly oblique, brownish-ochreous; a white costal streak from base to apex; cilia, pale grey. Hindwings, nearly 2, grey; cilia, grey-whitish.

Derwent Bridge, in January; one specimen (G. and C. Davis).

Xylorycta melanochrysa, n. sp.

μελανοχρυσος, black and gold.

♂. 24 mm. Head, black; face, whitish-ochreous. Palpi with second joint reaching base of antennae; terminal joint $\frac{2}{3}$, whitish-ochreous; terminal joint, blackish. Antennae, blackish; ciliations in male minute. Thorax, orange-yellow; patagia and a posterior spot, black. Abdomen, black; tuft and apices of joints beneath, yellow. Legs, black; anterior coxae, flexor surfaces, tarsal rings, and most of posterior pair yellow. Forewings, sub-oblong; costa, slightly arched; apex, rounded; termen, moderately oblique; orange-yellow with three broad black transverse fasciae; first sub-basal,

its posterior edge straight; second median, anterior edge from ⅓ costa to before mid-dorsum, slightly concave, posterior from beyond midcosta to ⅔ dorsum, angled outwards in middle of disc third terminal, its edge from ¾ costa to tornus, strongly convex; cilia, yellow; bases black, above tornus wholly black, before tornus wholly orange-yellow. Hindwings, 1; termen, sinuate, blackish; cilia, yellow; bases, blackish.

Hobart, in January; one specimen received from Capt. D. C. Pearse.

Lichenaula onychotypa, n. sp.

ὀνυχοτυπος, claw-marked.

♂. 20 mm. Head, white. Palpi with second joint not reaching base of antennae, terminal joint ⅔, white. Antennae, grey, towards base white; ciliations in male (1). Thorax, white; apices of tegulae and a posterior spot, fuscous. Legs, white; anterior pair, fuscous; middle tibiae and tarsi with fuscous rings. Forewings, sub-oblong; costa, moderately arched; apex, rounded; termen obliquely rounded; white heavily sprinkled with fusocus; markings, fuscous; an oblique, slightly curved line from beneath costa near base to near base of dorsum; a small dorsal suffusion, from middle of which a stout inwardly oblique line runs halfway across disc; an ill-defined fascia from midcosta to tornus; an erect line from tornus joining an elongate subapical costal spot, the posterior edge of which is again connected with tornus; a broad submarginal line from apex not reaching tornus; cilia, white with two interrupted fuscous lines. Hind wings, 1¼, whitish; extreme apex slightly suffused with grey; cilia, whitish, on apex, grey.

Hobart, in January; one specimen.

Procometis trispora, n. sp.

τρισπορός, three-spotted.

♀. 22mm. Head and thorax, fuscous-grey; face, grey-whitish. Palpi, smooth, slender, second joint reaching base of antennae; terminal joint ⅔, grey. Antennae, fuscous. Abdomen, grey; tuft, pale brownish. Legs, grey; posterior pair grey-whitish. Forewings, narrow; costa, moderately arched; apex, pointed; termen, extremely oblique; 7 to apex, grey with slight whitish irroration; markings, dark fuscous; a sub-basal dot just above fold; a large transverse spot at ⅓, apparently a fusion of a discal and a plical spot; a smaller spot in disc at ⅔; cilia, grey. Hindwings, 1½, grey; cilia, grey.

Hobart, in March; one specimen received from Capt. D. C. Pearse.

Family OECOPHORIDAE

The following species from Tasmania have been recently described.

Borkhausenia **nigripuncta* Turn. P.L.S.N.S.W., 1933, p. 93.

Macronemata Meyr. P.L.S.N.S.W., 1883, p. 345, **aphaurophanes* Turn., P.L.S.N.S.W., 1936, p. 305. Mt. Wellington (2500 feet).

Macronemata **omospila* Turn. P.L.S.N.S.W., 1936, p. 308. Mt. Wellington (2500 feet), Derwent Bridge, Gordon River.

Eccrita Turn. P.L.S.N.S.W., 1936, p. 317, **phaeoxysta* Turn., P.L.S.N.S.W., 1936, p. 317. Strahan.

Eulechria **phaeochorda* Turn. P.L.S.N.S.W., 1937, p. 96. Bothwell.

Eulechria **notera* Turn. P.L.S.N.S.W., 1938, p. 33. Mt. Wellington (2500 feet).

Eulechria **metaleuca* Turn. P.L.S.N.S.W., 1938, p. 33. Mt. Wellington (2500 feet).

Eulechria **ochrophara* Turn. P.L.S.N.S.W., 1938, p. 33. Strahan.

Eulechria **botryospila* Turn. P.L.S.N.S.W., 1936, p. 47. Deloraine.

(*See footnote to p. 66.)

Leptocroca stictocrossa, n. sp.

στικτοκροσσος, with dotted border.

♀. 20-22 mm. Head and thorax, grey. Palpi with second joint not reaching base of antennae, terminal joint $\frac{2}{3}$, grey. Antennae, grey; ciliations in male 1. Abdomen, grey; tuft, ochreous-whitish. Legs, grey; posterior pair, ochreous-whitish. Forewings, narrowly elongate-oval; costa, rather strongly arched; apex, pointed; termen, strongly oblique; 2 and 3 stalked; grey sprinkled with fuscous, which sometimes forms fine longitudinal lines; stigmata obscure, fuscous, usually minute, first discal at $\frac{1}{3}$, plical before it, second discal before $\frac{2}{3}$; a short, whitish transverse bar above tornus; a submarginal series of fuscous dots along termen and apical half of costa; cilia, grey-whitish, bases barred with fuscous. Hindwings, pale grey; cilia, whitish.

Allied to *L. eucentra*. Apart from differences in coloration, the antennal ciliations are much shorter.

Mt. Wellington, Derwent Bridge, and Mt. Barrow, in February; three specimens received from Mr. G. M. Goldfinch, who has the type.

Leptocroca diachorda, n. sp.

διαχορδος, strung right through.

♀. 22 mm. Head and thorax, white densely sprinkled with fuscous. Palpi with second joint much exceeding base of antennae; terminal joint scarcely more than $\frac{1}{2}$, white; terminal joint and a subapical ring on second joint dark fuscous. Antennae, fuscous

narrowly ringed with white. Abdomen with basal segments grey on dorsum; terminal, ochreous; tuft, sides, and lower surface, whitish. Legs, fuscous with whitish rings; posterior pair whitish. Forewings, suboval, rather narrow; costa, gently arched; apex, rounded; termen, very obliquely rounded, white unevenly sprinkled with fuscous; markings, dark fuscous; a small spot on base of costa; a strongly marked subcostal streak from base, somewhat irregular and two or three times interrupted, near apex sharply angled into a fine subterminal line to tornus; a series of elongate dots on apical $\frac{1}{5}$ of costa prolonged along termen, but becoming confluent and less conspicuous towards tornus; cilia, pale grey, barred on costal spots; apices, white. Hindwings and cilia, pale grey.

Very like *L. sphaleropis* Meyr., but with a much longer streak on forewings and shorter terminal joint of palpi. In that species the terminal joint is $\frac{3}{4}$, the antennae are grey, and the dorsum of the abdomen grey with white edges to the segments.

Barea tanaodes, n. sp.

ταναωδης, long.

♂. 23-26 mm. Head, brown-whitish. Palpi with second joint exceeding base of antennae; terminal joint $\frac{2}{3}$, fuscous; apex of second joint, whitish. Antennae, whitish annulated with pale fuscous; ciliations in male 1. Thorax, brown-whitish anteriorly sprinkled with fuscous; a posterior fuscous spot. Abdomen, pale ochreous-grey. Legs, fuscous with ochreous whitish rings; posterior pair mostly ochreous-whitish. Forewings, elongate, somewhat dilated posteriorly; costa, moderately arched; apex, rounded; termen obliquely rounded; 2 and 3 stalked; brown-whitish densely irrorated with fuscous; markings, dark fuscous; a whitish basal spot; an irregular suffused basal patch variable in extent; first discal at $\frac{1}{3}$, plical slightly before it, second discal before $\frac{2}{3}$; an interrupted line or series of dots from costa at $\frac{1}{4}$ running close to margin around apex and termen to tornus, between it and termen a series of pale spots; cilia, grey sprinkled with fuscous; apices, ochreous-whitish. Hindwings broader than forewings; grey-whitish; cilia whitish.

. This appears to be near *B. fenicoma* Meyr., from Mt. Kosciusko. One of my examples has 2 and 3 of forewings coincident on both sides, the other being normal. It is necessary to regard this as an individual aberration. I have an example of *Philobota orphnites* Turn., in which a similar abnormality occurs, and unfortunately led me to describe it as the type of a new genus *Atribasta*.

Waratah, in January and February; two specimens; Mt. Wellington, in February (Goldfinch).

Locheutis delopasta, n. sp.

δηλοπαστος heavily sprinkled.

♂. 16 mm. Head and thorax, fuscous. Palpi with second joint exceeding base of antennae; terminal joint $\frac{2}{3}$, fuscous; extreme apex of second joint, whitish. Antennae, fuscous; in male with tufts of long cilia ($2\frac{1}{2}$). Abdomen, ochreous-grey. Legs, fuscous with whitish rings (posterior pair missing). Forewings, narrow; costa, gently arched; apex, rounded; termen, very oblique, brownish-grey; markings and irroration dark fuscous; a dot on base of costa, closely followed by another beneath costa; a dot on base of dorsum; first discal at $\frac{1}{3}$, plical much before it, second discal about middle; a suffused costal spot beyond middle and another towards apex; cilia, grey. Hindwings and cilia, grey.

Waratah, in January; one specimen.

Elaeonoma typhodes, n. sp.

τυφωδης, smokey.

♂. 23 mm. Head and thorax, whitish. Palpi with second joint much exceeding base of antennae; terminal joint $\frac{2}{3}$, fuscous; inner surface and apex of second joint whitish. Antennae, ochreous-whitish; ciliations in male 1. Abdomen, ochreous-grey-whitish. Legs, fuscous with ochreous-whitish rings; posterior pair, whitish. Forewings, elongate, somewhat dilated; costa, slightly arched; apex, rounded; termen, obliquely rounded, ochreous-whitish sprinkled with fuscous, more densely on basal half of dorsal area; a fuscous discal dot at $\frac{2}{3}$; cilia, ochreous-whitish. Hindwings and cilia, whitish.

The type is in rather poor condition.

Mt. Wellington (2500 feet), in February; one specimen.

Mermeristis thioptera, n. sp.

θειοπτερος, sulphur-winged.

♂. 10-12 mm. Head and thorax, pale yellow. Palpi with second joint scarcely reaching base of antennae; terminal joint $\frac{1}{2}$, pale yellow. Antennae, fuscous; ciliations in male 5. Abdomen, fuscous; tuft, ochreous-whitish. Legs, fuscous. Forewings, narrow, dilated posteriorly; costa, gently arched; termen, oblique, pale yellow; costal edge near base, blackish; stigmata, blackish, first discal at $\frac{1}{3}$, plical before it, second discal before $\frac{2}{3}$; a round patch of fuscous suffusion between second discal and tornus; cilia, grey; bases, blackish; on apex and costa, pale yellow. Hindwings, narrowly elongate-ovate, fuscous; cilia, fuscous.

Mt. Wellington, Russell Falls, Zeehan, and Cradle Mountain (3000 feet), in February; five specimens. Type in Coll. Goldfinch.

Macronemata dielipha, n. sp.

διηλιφος, well anointed.

♂. 12 mm. Head, whitish-ochreous. Palpi with second joint not reaching base of antennae; terminal joint $\frac{1}{3}$, whitish-ochreous; external surface, except apex of second joint, fuscous. Antennae, fuscous; ciliations in male 1. Thorax, dark fuscous. Abdomen, dark fuscous; tuft, ochreous-whitish. Legs, fuscous; posterior pair, grey-whitish. Forewings, narrow; costa, moderately arched; apex, pointed; termen, very oblique, glossy ochreous-whitish; markings, dark fuscous; a narrow basal fascia shortly produced on costa; a subtriangular costal spot beyond middle and another at apex; a discal dot at $\frac{2}{3}$; cilia, fuscous, below midtermen, whitish. Hindwings and cilia, grey.

Mt. Wellington (1500 feet), in January; one specimen.

Macronemata pauxilla, n. sp.

pauxillus, small.

♂. 11 mm. Head, thorax, and abdomen fuscous. Palpi with second joint not reaching base of antennae; terminal joint $\frac{2}{5}$, fuscous. Antennae, fuscous; ciliations in male 4. Legs, fuscous. Forewings, narrow, suboval; costa, gently arched; apex, rounded; termen, very oblique, grey, lightly sprinkled with fuscous; discals, fuscous, approximated, first at $\frac{2}{5}$, second at $\frac{3}{5}$, plical obsolete; cilia, grey with fuscous points. Hindwings and cilia, grey.

Scottsdale, in January; one specimen.

Macronemata lioptera, n. sp.

λειοπτερος, smooth-winged.

♀. 18 mm. Head, thorax, abdomen, and legs, pale grey. Palpi, slender, second joint reaching base of antennae; terminal joint $\frac{2}{5}$, pale grey. Forewings, very narrow; costa, straight to near apex, there arched, apex acute; termen very oblique, grey; a quadrangular costal area from near base to $\frac{3}{4}$ and reaching middle of disc, white; discals, fuscous, at $\frac{2}{5}$ and $\frac{3}{4}$ on edge of whitish area, plical obsolete; cilia, whitish. Hindwings, pale grey; cilia, whitish.

Derby, in January; one specimen.

Macronemata leucocrana, n. sp.

λευκοκρανος, with white head.

♀. 17 mm. Head, whitish. Palpi with second joint exceeding base of antennae; terminal joint $\frac{3}{5}$, fuscous; base and extreme apex of second joint and whole internal surface, whitish. Antennae, fuscous. Thorax, grey; patagia, whitish. Abdomen, grey; tuft, whitish. Legs, fuscous (posterior pair missing). Forewings, narrow, somewhate dilated posteriorly; costa, very slightly arched; apex, pointed; termen, very oblique; whitish, unevenly sprinkled with fuscouse; this irroration is very scanty in costal and central areas, more abundant in basal $\frac{3}{4}$ of dorsal area, and forms ill-defined spots on costa before apex and on tornus, and an ill-defined terminal line; stigmata, fuscous, first discal at $\frac{1}{3}$, plical beyond it, second discal at $\frac{2}{3}$, connected with tornal suffusion, a dot above and between discals; cilia, whitish. Hindwings, broadly lanceolate, grey-whitish; cilia, whitish.

An obscure species, but characterized by the whitish head, whitish ground-colour of forewings, almost whitish hindwings, and long palpi.

Waratah, in December; one specimen.

Eulechria goniosticha, n. sp.

γωνιοστιχος, with angled line.

♂ ♀. 20 mm. Head and thorax, brownish-grey. Palpi with second joint much exceeding base of antennae, $2\frac{1}{2}$ times length of face; terminal joint $\frac{3}{4}$, fuscous; inner surface and apex of second joint, grey. Antennae ochreous-grey; ciliations in male $1\frac{1}{2}$. Abdomen, ochreous-grey-whitish. Legs, fuscous; posterior pair, ochreous-whitish. Forewings, narrow, slightly dilated; costa moderately arched; apex, round-pointed; termen oblique, whitish-ochreous; markings and some scattered scales blackish, sometimes a basal costal dot; first discal at $\frac{1}{4}$, plical beyond, second discal at middle; an interrupted inwardly-oblique line from $\frac{5}{6}$ costa, sharply indented above middle, thence curved to tornus; in the female example this line is scarcely traceable; cilia, whitish-ochreous. Hindwings and cilia, pale grey.

Weldborough, in January; two specimens.

Eulechria albifrons, n. sp.

albifrons, white-faced.

♂. 20 mm. Head and thorax, pale grey; face, white. Palpi with second joint reaching base of antennae; terminal joint $\frac{3}{5}$, pale grey; terminal joint and apex of second joint, white. Antennae,

pale grey; ciliations in male 1½. (Abdomen missing). Legs, fuscous (posterior pair missing). Forewings, elongate, narrow; costa, gently arched; apex, pointed; termen, very oblique; pale grey; a white costal streak from base to beyond middle; cilia, pale grey. Hindwings and cilia, whitish.

Waratah, in February; one specimen.

Eulechria irenitis, n. sp.

εἰρηνιτις, peaceful.

♂♀. 20-22 mm. Head, white. Palpi with second joint reaching base of antennae; terminal joint ⅓, fuscous or grey; terminal joint and apex of second joint white. Antennae, ochreous-grey; ciliations in male 5. Thorax, pale ochreous-grey. Abdomen, grey; apices of segments and tuft, whitish. Legs, grey; posterior pair, ochreous-whitish. Forewings, elongate, somewhat dilated; costa, slightly arched; apex, rectangular; termen, moderately oblique, whitish-grey sparsely sprinkled with pale ochreous; a suffused whitish costal streak before middle; some fuscous scales on costa beyond middle and on apex and termen; cilia, whitish, on apex, fuscous. Hindwings and cilia, whitish.

Not unlike the preceding, but the antennal ciliations are much longer.

Cradle Mountain (3000 feet), in January; two specimens received from Mr. W. B. Barnard.

Eulechria spreta, n. sp.

spretus, despised.

♂. 20 mm. Head and thorax, fuscous. Palpi with second joint reaching base of antennae; terminal joint ⅜, grey; outer surface of second joint fuscous. Antennae, grey, ciliations in male 1¼. Abdomen, grey; dorsum of terminal segments partly brownish. Legs, fuscous; posterior pair grey-whitish. Forewings, somewhat dilated; costa, gently arched; apex, obtusely pointed; termen, oblique; light fuscous with some dark fuscous sprinkling; markings, dark fuscous; stigmata, dot-like, first discal at ⅓, plical beyond it, second discal before ⅔; a line of minute dots from ⅔ costa obliquely outwards angled rectangular before apex, thence curved parallel to tornus; cilia, light fuscous. Hindwings and cilia, pale grey.

This may be placed before *E. lissopolia* Turn.

St. Marys, in January; one specimen.

Machimia phaeoporphyra, n. sp.

φαιοπορφυρος, dusky purple.

♂. 22 mm. Head and thorax, purple-grey. Palpi with second joint exceeding base of antennae; terminal joint $\frac{2}{3}$, grey. Antennae, fuscous; ciliations in male 1. Abdomen, grey; apices of segments and tuft, grey-whitish. Legs, grey-whitish; anterior pair, fuscous Forewings, broad, posteriorly dilated; costa, strongly arched; apex, rounded-rectangular; termen, slightly rounded; slightly oblique, grey-whitish very densely irrorated with purple-grey; stigmata, minute, almost imperceptible, first discal at $\frac{1}{3}$, plical beyond it, second discal before $\frac{2}{3}$; cilia, grey-whitish with darker points. Hindwings, broadly ovate; pale grey; cilia, pale grey.

Dark in colour for this genus, but agreeing structurally.

Derwent Bridge, in January; one specimen.

Machimia rubella, n. sp.

rubellus, pink.

♂. 30-32 mm. Head and thorax, pale ochreous-pink. Palpi with second joint exceeding base of antennae; terminal joint $\frac{3}{5}$ to $\frac{3}{4}$, pale pinkish, towards base ochreous-whitish. Antennae, grey towards base ochreous-tinged; ciliations in male $\frac{1}{2}$. Abdomen, grey; apices of segments ochreous-whitish; tuft, whitish-ochreous. Legs, ochreous-whitish; anterior pair, pinkish-fuscous. Forewings, moderately broad; costa, strongly arched; apex, rounded-rectangular; termen, slightly rounded, slightly oblique, pale pink (slightly inclined to be rosy-purple), in one example greyish-pink; costa, narrowly pink, extreme edge whitish; markings, inconspicuous, fuscous, or partly reddish; first discal at $\frac{1}{3}$, plical beyond it, second discal before $\frac{2}{3}$; a line of minute dots from midcosta obliquely outwards, sharply angled midway between second discal and apex, thence curved inwards to tornus; a terminal series of dots; cilia, pink; apices, whitish. Hindwings, ochreous-whitish slightly suffused with grey, except near base; cilia, ochreous-whitish.

The forewings of *M. brachytricha* are ochreous-pink, inclining to pale brick-red.

Derwent Bridge in January; seven specimens all ♂, one ♀ 27 mm. Triabunna.

Machaeretis compsa, n. sp.

κομψος, neat.

♂. 10-13 mm. Head, grey-whitish or ochreous-whitish. Palpi with terminal joint $\frac{3}{5}$, fuscous, inner surface, whitish. Antennae, grey annulated with fuscous; ciliations in male 3. Thorax, pale grey. Abdomen, grey. Legs, fuscous; posterior pair, grey. Forewings, narrow; costa, gently arched; apex, round-pointed; termen,

oblique, ochreous-whitish; markings and some irroration fuscous; a sharply defined somewhat elongate basal costal spot; first discal at $\frac{2}{5}$, plical well before it, but the former is usually, and the latter often, not developed, second discal at $\frac{2}{3}$; in one example a costal spot at $\frac{3}{5}$; an interrupted subterminal line, sharply indented beneath costa, thence obliquely curved to $\frac{2}{3}$ dorsum, usually partly or wholly obsolete; cilia, ochreous-whitish. Hindwings and cilia, grey.

I formerly confused this with *M. psathyra* Meyr., of which I had not then seen an example. It may be distinguished by the sharply defined basal costal spot and the much larger antennal ciliation (in *psathyra* at most $1\frac{1}{2}$).

Cradle Mountain (3000 feet), Russell Falls, and Lake Fenton (3500 feet), in January; eight specimens.

Haplodyta ochrogramma, n. sp.

ὠχρογραμμος, with pale marking.

♂. 18-19 mm. Head and thorax, fuscous. Palpi with second joint exceeding base of antennae; terminal joint $\frac{2}{3}$, fuscous. Antennae, fuscous; ciliations in male 2. Abdomen, grey; bases of segments ferruginous-fuscous on dorsum. Legs, fuscous; posterior pair, pale grey. Forewings, narrow; costa, slightly arched; apex, acute; termen, straight, oblique, slightly sinuate beneath apex, fuscous; a broad grey-whitish streak from base narrowing to mid-dorsum, edged above by blackish suffusion; a whitish dot in disc below middle at $\frac{2}{5}$; stigmata obscure or undeveloped, first discal at $\frac{1}{3}$, second touching upper side of whitish dot; cilia, fuscous. Hindwings and cilia, grey.

Weldborough and Derby, in January; two specimens.

Coesyra cerochyta, n. sp.

κηροχυτος, waxen.

♂. 20 mm. Head and thorax, ochreous-whitish. Palpi, with terminal joint $\frac{2}{3}$, ochreous-whitish. Antennae, pale grey; ciliations in male 2. Abdomen, grey. Legs, fuscous; posterior pair, grey. Forewings with costa moderately arched; apex, rounded; termen, obliquely rounded; glossy ochreous-whitish; costal edge blackish near base; stigmata, dotlike but distinct, blackish, first discal at $\frac{1}{3}$, plical well beyond it, second discal at $\frac{2}{3}$, cilia, ochreous-whitish. Hindwings and cilia, grey.

Easily distinguished from *C. ochrocirrha* Turn., which it resembles, by the plical dot being beyond first discal.

Mt. Wellington (2500 feet), in January; one specimen.

Pyrgoptila dasciopa, n. sp.

δασκιωπος, dark.

♀. 24 mm. (Head badly rubbed.) Antennae, fuscous. Palpi with second joint more than three times length of face, terminal joint ⅔, fuscous, second joint with apex and inner surface whitish. Thorax, fuscous; posterior part of crest whitish. Abdomen, grey. Legs, fuscous, more or less suffused with whitish. Forewings, elongate, slightly dilated; costa moderately arched; apex, round-pointed; termen very oblique, fuscous lightly sprinkled with whitish and with some dark fuscous suffusion; a whitish basal dot; an elongate whitish spot on dorsum near base; stigmata, dark fuscous edged posteriorly with whitish, first discal at ⅓, plical beyond it, second discal slightly beyond middle; a subdorsal ridge of dark fuscous scales from base to ⅔, terminating in a tuft, which is edged posteriorly by a short, oblique ochreous-whitish streak; beyond this is a smaller crest of dark fuscous scales; some whitish suffusion on costa before apex, on dorsum before tornus, and before termen; cilia, grey-whitish sprinkled with fuscous. Hindwings and cilia, whitish-grey.

Scottsdale, in January; one specimen.

Pyrgoptila mochlonota, n. sp.

μοχλονωτος, with bar on dorsum.

♂. 20-22 mm. ♀ 18 mm. Head and thorax, fuscous. Palpi, with second joint exceeding base of antennae; terminal joint, ½ in male, ⅔ in female; whitish, more or less sprinkled with fuscous; terminal joint, mostly fuscous, but apex whitish. Antennae, fuscous; ciliation in male, 2. Abdomen, grey; bases of segments, ferruginous in male; tuft, grey-whitish. Legs, fuscous, with whitish tarsal rings; posterior pair, mostly whitish. Forewings rather narrow, strongly dilated; costa, gently arched; apex, pointed; termen, oblique, fuscous-grey; a broad grey-whitish dorsal bar, with a small median projection, from mid-base to tornus, separated from dorsum near base, edged above by dark fuscous suffusion; stigmata, dark fuscous, first discal at ⅓, sometimes edged posteriorly with white; plical, lost in suffusion, second discal, at ⅔, with a white spot beneath it; in female a dot above and between discals; cilia, grey, sprinkled with dark fuscous—on tornus, grey-whitish. Hindwings and cilia, pale grey.

Triabunna (2 ♀), Derwent Bridge (♂), and Waratah (♂ type), in February; four specimens received from Mr. G. M. Goldfinch who has the type.

Philobota chrysosticha, n. sp.

χρυσοστιχος, gold-streaked.

♂, 22-26 mm. ♀, 20-22 mm. Head, orange-yellow; face fuscous. Palpi, with second joint exceeding base of antennae; terminal joint, $\frac{2}{3}$; fuscous, posterior surface, whitish. Antennae, fuscous; ciliations in male, $2\frac{1}{2}$. Thorax, fuscous. Abdomen, grey, darker towards base; apices of segments, whitish. Legs, fuscous,; posterior pair, grey or grey-whitish. Forewings, dilated posteriorly in male; narrower in female; costa, gently arched; apex, round-pointed; termen, obliquely rounded; slaty-grey; a white costal streak from base to $\frac{2}{3}$; a series of orange-yellow (rarely pale yellow) streaks; a narrow streak beneath costa to $\frac{2}{3}$; a median streak from $\frac{1}{3}$ to termen beneath apex, giving off a branch to apical part of costa and a short branch to midtermen; a streak along fold from base to tornus; a dorsal streak to beyond middle, sometimes imperfectly developed; cilia, grey. Hindwings and cilia, pale grey.

This should not be confused with the allied *P. aurceps* Butl. In that species the colour of forewings is bright yellow, with variably developed dark fuscous streaks and small apical blotch.

Hobart, Derwent Bridge (2000ft.), and Cradle Mountain (3000 feet), in January. Victoria: Mt. Buffalo (4000 feet) and Mt. Erica (5000 feet), in January and February. New South Wales: Mt. Kosciusko (5500 feet), in January; Tweed Heads (Coolangatta), in September. This is a mountain species. Its occurrence at Hobart may be attributed to the vicinity of Mt. Wellington, and the solitary example from Coolangatta is probably a straggler from the Macpherson Range. The type is from Cradle Mountain.

Philobota metarga, n. sp.

μεταργος, white posteriorly.

♂♀, 20 mm. Head and thorax, grey-whitish. Palpi, with second joint exceeding base of antennae; terminal joint, $\frac{2}{3}$; whitish, external surface of second joint, except apex, fuscous. Antennae, grey; ciliations in male, 2. Abdomen, ochreous-grey; apices of segments and tuft, whitish-grey. Legs, fuscous, with whitish rings; posterior pair, whitish. Forewings, narrow, slightly dilated; costa, slightly arched; apex, pointed; termen obliquely rounded; grey-whitish; markings and some irroration, dark fuscous; basal dots on costa and dorsum; first discal, at $\frac{1}{3}$; plical, beneath or slightly beyond; second discal, before $\frac{2}{3}$; an interrupted line or series of dots from $\frac{3}{4}$ costa obliquely outwards, angled beneath costa and continued parallel to termen to tornus; cilia, grey-whitish. Hindwings and cilia, white.

Hobart and Mt. Wellington (2500 feet), in February; four specimens.

Philobota fulvella, n. sp.

fulvus, brownish-yellow.

♂♀. 16-18 mm. Head and thorax, brownish-yellow;; face, whitish. Palpi, with second joint just reaching base of antennae; terminal joint, ½; brownish-yellow. Antennae, grey; ciliations in male, 1½. Abdomen, grey; tuft, whitish-ochreous. Legs, grey; posterior pair, whitish. Forewings, rather broad, dilated posteriorly; costa gently arched; apex, obtusely pointed; termen moderately oblique; brownish-yellow; costal edge, fuscous towards base; terminal edge, sometimes grey; cilia, whitish; bases, grey. Hindwings and cilia, grey.

Broader-winged than its allies *P.* tyroxantha Meyr., in which second joint of palpi exceeds base of antennae, *P. melichrodes* Turn., which has a whitish head, and *P. mlirrhoa* Meyr., which has the thorax anteriorly fuscous.

Strahan, in January; three specimens.

Philobota crypsirrhoda, n. sp.

κρυψιρρόδος, with hidden rose-colour.

♂. 19-20 mm. Head, pale yellow; sides of face, reddish. Palpi, with second joint reaching base of antennae; terminal joint, ½, slender; pale yellow; outer surface of second joint, rosy-suffused. Antennae, grey; basal joint, reddish; pecten, rosy; ciliations in male, 1. Thorax, reddish (partly descaled). Abdomen, whitish; dorsum of anterior segments, grey-brown; tuft, dark fuscous. Legs, pale yellowish. Anterior pair, fuscous, reddish-tinged; posterior pair, with spurs and proximal tarsal joints, fuscous. Forewings, subtriangular; costa gently arched; apex, obtusely pointed; termen, very obliquely rounded; yellow; a purple-fuscous costal streak from base to ⅔, edged beneath with reddish; a broad, oblique, purple-fuscous line, edged with reddish from costa near apex to midtermen; cilia, yellow—on apex reddish. Hindwings, whitish, tinged, rosy posteriorly; cilia, yellow. Underside of forewings, almost wholly bright rosy.

An isolated species not near any other.

Hobart, in February; two specimens received from Capt. D. C. Pearse.

Philobota dolichothrix, n. sp.

δολιχοθριξ, long-haired.

♂. 16 mm. Head, white. Palpi, with second joint reaching base of antennae; terminal joint, ⅔; whitish. Antennae, grey; ciliations in male, 6. Thorax and abodmen, pale grey. Legs, grey; posterior pair, whitish. Forewings, narrow, suboval; costa, moderately arched; apex, pointed; termen, very oblique; white; markings, pale grey; stigmata, large suffused spots, first discal at ⅔, plical

beneath and more or less confluent with it, second discal at $\frac{2}{3}$; a suffused spot on tornus and a sprinkling of pale grey scales in terminal part of disc; cilia, white. Hindwings and cilia, whitish-grey.

Remarkable for the extremely long antennal ciliations of the male.

Tasman Peninsula and Strahan, in January; two specimens.

Philobota casta, n. sp.

castus, spotless.

♀ ♂. 17-18 mm. Head and thorax, grey-whitish. Palpi, with second joint just reaching base of antennae; terminal joint, $\frac{1}{4}$; grey-whitish. Antennae, grey-whitish; ciliations, in male, 3. Abdomen, grey. Legs, pale grey; posterior pair, whitish. Forewings, elongate, narrow; costa, gently arched; apex, pointed; termen, very oblique; grey-whitish; cilia, grey-whitish. Hindwings and cilia, whitish.

Mt. Wellington (2500 feet), in January and February; three specimens.

Leistomorpha trissosema, n. sp.

τρισσοσημος, three-marked.

♂. 15-17 mm. Head, thorax, and abdomen, dark fuscous. Palpi, with second joint reaching base of antennae; terminal joint, $\frac{1}{4}$; dark fuscous. Antennae, dark fuscous; ciliations in male, $2\frac{1}{2}$. Legs, dark fuscous, with ochreous-whitish rings; mid and posterior tibiae, with median and terminal whorls of short, ochreous-whitish hairs. Forewings, rather narrow; costa, gently arched; apex, obtusely pointed; termen straight, oblique; dark fuscous; a short, outwardly oblique, ochreous-whitish mark from dorsum beyond middle; similar, but shorter, marks on costa at $\frac{1}{3}$ and $\frac{2}{3}$, but these may be weakly developed or obsolete; a few ochreous-whitish scales in terminal area; cilia, dark fuscous; apices, ochreous-whitish. Hindwings and cilia, dark grey.

This genus has the pecten absent or represented by one or scales only. The present species is peculiar in its tibial structure, but appears nearly allied to *L. brontoscopa*.

Derwent Bridge, in February; three specimens received from Mr. G. M. Goldfinch, who has the type.

Chrysonoma platyzostra, n. sp.

πλατυξωστρος, broadly banded.

♀. 22 mm. Head and thorax, whitish. Palpi, with second joint exceeding base of antennae; terminal joint slender, nearly as long as second ($\frac{5}{6}$); fuscous. Antennae, fuscous. Abdomen, grey; apices of segments and tuft, whitish-ochreous. Legs, fuscous; posterior tibiae, whitish-ochreous. Forewings, with costa moderately

arched; apex, round-pointed; termen, straight, moderately oblique; ochreous-whitish; costal edge at base, blackish; markings, fuscous; a broad, antemedian fascia; anterior edge from $\frac{1}{3}$ costa to $\frac{1}{4}$ dorsum; posterior, from midcosta to mid-dorsum, both somewhat wavy; a fascia from $\frac{2}{3}$ costa to tornus, narrow on costa, soon broadening in disc; a triangular terminal blotch, from apex nearly to tornus; cilia, whitish-ochreous on apex, broadly fuscous. Hindwings, grey; cilia, whitish.

Tasman Peninsula, in January; one specimen.

Fam. HYPONOMEUTIDAE

Zelleria malacodes, n. sp.

μαγακωδης, soft.

♀. 14 mm. Head and thorax, grey-whitish. Palpi, whitish. Antennae, grey-whitish. Abdomen, pale grey; tuft, whitish. Forewings, narrow; costa, strongly arched; apex, acute, produced; grey-whitish; a few blackish points near costa, above tornus, and at apex; cilia, whitish; on apex grey. Hindwings, lanceolate; cilia, 1; whitish; cilia, whitish.

Cradle Mountain (3000 feet), in February; one specimen.

Gen. **Amblyzancla**, nov.

ἀμβλυξαγκλος, with obtuse sickles.

Tongue, present. Palpi, moderately long, curved, ascending, not reaching vertex, smooth-scaled; second joint, long slightly expanded at apex; terminal joint, short, obtuse. Antennae, $\frac{3}{4}$; in male, shortly ciliated. Forewings, with 7 and 8 stalked, 7 to apex. Hindwings, with 3 absent, 5, 6, 7 approximately at origin.

Amblyzancla araeoptila, n. sp.

ἀραιοπτιλος, narrow-winged.

♂. 15 mm. Head, palpi, and thorax whitish-grey. Antennae, grey; ciliations in male $\frac{1}{4}$. Abdomen, grey. Legs, grey (posterior pair missing). Forewings, narrow; costa, slightly arched; apex, acute; grey, sprinkled with whitish, minute, blackish discal dots at middle and $\frac{3}{4}$, the former connected by an inwardly oblique line with dorsum before middle; a blackish apical spot; cilia, grey, on apex, blackish. Hindwings, narrow-lanceolate; cilia, 3; grey; cilia, grey.

St. Marys, in January; one specimen.

Gen. **Anoista**, nov.

ἀνωιστος, unlooked for, unforeseen.

Head, smooth-scaled; sidetufts, moderate. Tongue, present. Maxillary palpi, obsolete. Labial palpi, ascending, recurved, moderately stout, smooth-scaled; second joint not reaching base of antennae; terminal joint, $\frac{1}{3}$, rather stout, obtusely pointed. Antennae, without basal pecten. Thorax, smooth. Posterior tibiae, smooth-scaled; spurs, especially inner ones, long. Forewings, with all veins present and separate, 2, 3, 4, 5, 6, equidistant, 3 from angle, 7 to apex, well separated at origin from 8, 11 from middle. Hindwings, with 2 from near angle, 3 and 4 short-stalked, 5 approximated to 6 at origin, 6 and 7 well separate, parallel nearly to their middle, thence slightly diverging.

A somewhat anomalous and rather primitive genus. The type species is in general appearance an *Oecophorid*, but the separate 7 of forewings and the smooth posterior tibiae undoubtedly refer it to the *Hyponomeutidae*.

Anoista insolita, n. sp.

insolitus, unusual, strange.

♂. 18-20 mm. Head, grey-whitish. Palpi, fuscous; apex of terminal and inner surface of second joint, whitish. Antennae, grey; ciliations in male, $1\frac{1}{2}$. Thorax, pale grey; bases of tegulae, fuscous. Abdomen, whitish-ochreous. Legs, fuscous with whitish rings; posterior tibiae, grey or whitish. Forewings, elongate-oval; costa, rather strongly arched; apex pointed, termen, oblique; grey; costa, with fuscous strigulae; a broad white dorsal area joined by an outwardly oblique fascia from costa near base; a broad dark fuscous line partly double on outer edge of fascia almost reaching fold; a reddish-ochreous median spot immediately follows this, and from it a narrow, ochreous, longitudinal suffusion proceeds to $\frac{2}{3}$, and there expands fan-wise, not reaching margins; a white dot at about $\frac{2}{3}$ edged with dark fuscous lies in the upper fork of a small dark fuscous X mark; terminal veins, with series of dark fuscous dots; a small, dark fuscous blotch above tornus; cilia grey, bases barred with dark fuscous. Hindwings, elongate-ovate; apex, obtusely rounded; termen, not sinuate; whitish-grey; cilia, grey-whitish.

Derwent Bridge, in February; two specimens received from Mr. G. M. Goldfinch, who has the type.

Fam. GRACILARIADAE

Lithocolletis acares, n. sp.

ἀκαρης, tiny.

♂. 5-6 mm. Head and thorax, grey. Labial palpi, whitish; second and terminal joints, with broad median fuscous rings. Antennae, fuscous; in male simple. Abdomen and legs, fuscous. Forewings, narrow; costa, usually slightly, but in one example strongly arched; apex, pointed; rather dark grey; markings, white; a fine streak on fold from near base to first transverse line; first line from $\frac{1}{3}$ costa obliquely outwards to fold, there angled inwards to mid-dorsum; a short, but rather broad, oblique line from midcosta to middle of disc; second line transverse, slightly curved outwards from $\frac{2}{3}$ costa to tornus; third line from $\frac{5}{6}$ costa to termen above middle; a blackish apical dot; cilia, grey. Hindwings, linear-lanceolate; grey; cilia, 6, grey.

I have had difficulty in determining the genus of this minute species, and therefore give its structural characters. The head is loosely scaled, but not rough. The tongue is well developed. The labial palpi are long, porrect, mostly smooth, but with some long projecting scales on lower surface, and the maxillary palpi are minute, but distinct and porrect. All the tibiae are smooth-scaled. There can therefore be no doubt that it belongs to the *Gracilariadae*. I should have referred it to *Acrocercops*, if it had not been for the smooth posterior tibiae. It seems to agree fairly well with *Lithocolletis*, though the tibiae are exceptional and it has no near relationship to the two described Australian species.

Mt. Wellington (4000 feet), in January, locally abundant in a restricted area, covered with dwarf shrubs; eight specimens.

Phyllocnistis enchalcoa, n. sp.

ἐγχαλκος, brassy.

♂ ♀. 6-8 mm. Head and thorax, brassy. Palpi, white. Antennae, fuscous. Abdomen, fuscous. Legs, fuscous, with white rings. Forewings, rather narrow, dilated posteriorly; apex, obtuse; bright brassy-metallic; four narrow, shining, white transverse fasciae, each edged anteriorly by a fine blackish line, at $\frac{1}{4}$, middle, $\frac{3}{4}$, and subapical; a large blackish apical spot; cilia brassy, on apex and tornus, fuscous. Hindwings, linear-lanceolate; cilia, 5; grey; cilia, grey.

Hobart, in April. Dr. V. V. Hickman found these tiny moths in great numbers in his garden at New Town, and sent me specimens, which arrived dry, and were very difficult to deal with. Subsequently he sent others by air-mail. These arrived alive, but badly rubbed from having tried to escape through the cottonwool, with which the glass tube was plugged. However, they showed the structural

characters better. After a search made at my suggestion, he found blotches on the leaves of a native shrub *Plagianthes sidoides*. These contained cocoons, which were by this time either empty or parasitised.

Dr. Hickman informs me that the food plant is one of the *Malvaceae*, and sends the following particulars: "The egg is white and coarsely sculptured on the chorion. It is oval in shape, and measures 0·30 mm. long by 0·17 wide. The moth attaches the eggs to the stellate hairs on the underside of the leaf. Some were found to be hatching in April. The newly-hatched larva measures 0·48 mm. long. As soon as its head protrudes from the chorion, it commences to bore its way into the leaf. The empty chorion remains attached to the leaf for some time before a yellow blotch discloses the situation of the mine. The first two instars are completely apodous. In two dead, and apparently mature, larvae the thoracic legs and three pairs of prolegs are present."

Fam. PLUTELLIDAE

Gen. **Leurophanes**, nov.

λευροφανης, smooth.

Tongue, well developed. Labial palpi, long, slender, smooth, curved, ascending; second joint reaching base of antennae; terminal joint, shorter and more slender than second, acute. Maxillary palpi, minute. Antennae without basal pecten; ciliations in male, minute. Posterior tibiae, smooth. Forewings, with 2 and 3 stalked, 7 and 8 stalked, 7 to termen, 11 from middle. Hindwings, with 2 and 3 connate, 5 from below middle, 6 and 7 stalked.

Leurophanes oresibates, n. sp.

ὀρεσιβατης, mountain-ranging.

♂. 20-22 mm. Head, whitish. Palpi, with terminal joint $\frac{2}{3}$; whitish, external surface of second joint except apex, grey. Antennae and thorax, grey. Abdomen, pale grey; apices of segments and tuft whitish. Legs, fuscous; posterior pair pale grey. Forewings, elongate, costa moderately arched; apex, pointed; termen, straight, oblique; grey, brownish-tinged; a median whitish suffusion from base to $\frac{2}{3}$; a fuscous streak beneath this from $\frac{1}{3}$ to $\frac{2}{3}$, enlarged at posterior end, a suffused fuscous spot between this and apex; cilia, whitish, sometimes grey on apex and tornus. Hindwings, $1\frac{1}{2}$, elongate-ovate; grey-whitish; cilia, whitish.

Mt. Wellington (4000 feet), in January; four specimens.

Fam. LYONETIADAE

Dryadaula anthracodeta, n. sp.

ἀγθρακοδετος, black-rimmed.

♂ ♀. 12 mm. Head, palpi, antennae, and thorax, white. (Abdomen, missing.) Legs, fuscous, with white rings; posterior pair, mostly white. Forewings, narrow; costa straight to near apex; apex, conical; termen, extremely oblique; white; terminal area, partly suffused with pale fuscous; markings, black; a sub-basal costal dot, a larger subquadrate spot shortly beyond, and a still larger triangular spot at $\frac{2}{3}$; a pale fuscous suffusion from $\frac{2}{3}$ costa to tornus, with a short blackish posterior edge in middle; a second suffusion before apex, with a sharply defined posterior margin; an interrupted terminal line; cilia, white, on tornus, and apex pale fuscous. Hindwings, broadly lanceolate; grey, cilia, $\frac{1}{2}$, grey.

Mt. Wellington (2500 feet), in January; Cradle Mountain (3000 feet) and Stanley, in February; three specimens.

Dryadaula melanoptycha, n. sp.

μεγανοπτυχος, with black fold.

♂. 12 mm. Head and palpi, pale ochreous-grey. Antennae, grey; ciliations, in male, minute. Thorax, fuscous. Abdomen, whitish-grey. Legs, grey; posterior pair, paler. Forewings, narrow; costa, gently arched; apex, pointed; termen, very oblique; whitish-grey, with a few scattered dark fuscous scales; a broad white dorsal streak from base, narrowing to $\frac{2}{3}$ dorsum, edged above by an interrupted black line; cilia, whitish-grey. Hindwings, broadly lanceolate; whitish-grey; cilia, nearly 1, whitish.

Deloraine, in February; one specimen.

Dryadaula eutactopa, n. sp.

εὐτακτωπος, modest.

♂. 15 mm. Head, whitish-ochreous. Palpi, ochreous-whitish. Antennae, grey; ciliations in male, $\frac{1}{2}$. Thorax, white; bases of tegulae, fuscous. Abdomen, fuscous. Legs, fuscous, with whitish rings. Forewings, narrow, suboval; costa, slightly arched; apex, round-pointed; termen, very oblique; 7 and 8 coincident; grey, with some blackish and whitish scales; a blackish plical streak broadly inter-

rupted by two longitudinal white bars; a white median spot at $\frac{1}{3}$, followed by some blackish irroration; a short longitudinal blackish streak at $\frac{2}{3}$, followed by a white suffusion; cilia, whitish, with an interrupted blackish antemedian line. Hindwings, broadly lanceolate; dark grey; cilia, nearly 1, grey.

Derwent Bridge, in January; one specimen.

Erechthias ancistrosema, n. sp.

ἀγκιστροσημος, hook-marked.

♂. 10 mm. Head, whitish; lateral aspect, fuscous. Palpi, whitish. Antennae, dark fuscous; with basal pecten; ciliations, in male, minute. Thorax and abdomen, dark fuscous. Legs, fuscous; posterior pair with white rings and spurs. Forewings, narrow; apex, rounded; dark fuscous, with white markings; two fine, parallel, closely-approximated streaks from base to middle; oblique streaks from $\frac{1}{3}$ costa and from above $\frac{1}{3}$ dorsum, running into their apices; oblique streaks from $\frac{1}{3}$ dorsum and from $\frac{2}{3}$ and $\frac{5}{6}$ costa to mid-disc; a black apical spot, edged anteriorly with whitish; cilia, fuscous; bases whitish. Hindwings, broadly lanceolate; fuscous; cilia, $\frac{3}{4}$, grey.

Burnie, in January; one specimen.

Fam. TINEIDAE

Lepidoscia muricolor, n. sp.

muricolor, mouse-coloured.

♂. 12-14 mm. Head, palpi, antennae, thorax, abdomen, and legs, fuscous-grey. Antennal ciliations, in male, minute. Forewings, narrow, suboval; costa, straight to $\frac{3}{4}$, thence arched; apex, rounded; termen, obliquely rounded; 7 and 8, stalked; grey; cilia, grey. Hindwings with apex rounded; termen slightly rounded; grey, thinly scaled; cilia, grey.

Cradle Mountain (3000 feet), in February; seven specimens.

Narycia confluens, n. sp.

confluens, with confluent fasciae.

♂♀. 16 mm. Head, whitish. Palpi, antennae, and thorax, fuscous. Abdomen, fuscous; tuft, whitish-brown. Legs, fuscous. Forewings, suboval; costa, strongly arched; apex, round-pointed; termen, oblique; 7 and 8, stalked; white, with fuscous markings; a costal streak from base to $\frac{1}{4}$; a fascia from $\frac{1}{4}$ costa to $\frac{1}{4}$ dorsum; converging fasciae from $\frac{1}{3}$ and $\frac{2}{3}$ costa, uniting in mid-disc and running to a point at mid-dorsum; a fascia from $\frac{2}{3}$ costa to tornus,

sometimes confluent on costa, with preceding and enclosing median white dots on costa and tornus; a subterminal fascia from costa to termen above tornus; terminal edge from this to apex, fuscous; cilia, fuscous, on tornus, white. Hindwings, with apex pointed; termen, slightly rounded; grey; a suffused, whitish, submarginal fascia; cilia grey.

Hobart, in October; Burnie, in January; two specimens.

Gen. **Cuphomorpha**, nov.

κουφομορφος, slightly built.

Tongue, present. Face, rough-scaled. Labial palpi, long, slender porrect or drooping; terminal joint as long as second, acute. Maxillary palpi, obsolete. Antennae longer than forewings, with strong basal pecten; in male, joints triangularly dilated at apices and shortly ciliated; in female, simple. Posterior tibiae, hairy. Forewings, with all veins present and separate. Hindwings, with 3 and 4 coincident, 6 and 7 nearly parallel.

Allied to *Macraeola* Meyr.

Cuphomorpha tanyceros, n. sp.

ταννκερως, long-horned.

♂. 16-17 mm. ♀. 14 mm. Head, thorax, and abdomen, grey. Palpi, fuscous; base and apex of terminal joint, whitish. Antennae fuscous; ciliations, in male, ½. Legs, fuscous; posterior pair, grey-whitish. Forewings, elongate-oval; costa, strongly arched; apex, pointed; termen, very oblique; pale, glossy grey; two rather large, ochreous-whitish, discal spots; first at ⅓, suboblong, diffusely, but partially edged with dark fuscous; second at ⅔, with a broad, suffused, oblique extension nearly to tornus; cilia, pale grey. Hindwings, with apex rounded; termen, only slightly rounded; pale grey; cilia, whitish-grey.

Mt. Wellington (2500 feet), in Febraury; Strahan, in January; three specimens.

Fam. HEPIALIDAE

Jeana timetea, n. sp.

τιμητεος, worthy of honour.

♂. 30 mm. Head and palpi, fuscous. Antennae, grey; pectinations in male, 2½, each ending in a long terminal bristle. Thorax, dark reddish-brown. Abdomen, fuscous; tuft, reddish-brown; under side, pale ochreous. Legs, pale ochreous; anterior pair, fuscous; all with whitish tibial hairs. Forewings, rather broadly triangular;

costa, almost straight; apex, rounded; termen, obliquely rounded; reddish-brown; some fine whitish strigulae near costa and in apical area; a pale ochreous spot on base of dorsum; basal area defined, except towards costa, by a whitish grey, slender, transverse line, curved inwards below middle of disc, and thence oblique to ¼ dorsum; in the included area are some blackish dots, partly outlined with whitish; touching this line anteriorly, are three broad longitudinal marks, first above middle contains a narrow oblique, clear, white, mark, second below middle contains a clear, white dot, third subdorsal is mixed with whitish posteriorly, a pale, ochreous, subquadrate area between upper white mark and termen, traversed by a fine, blackish, transverse line; a whitish subterminal line, preceded by several blackish spots; cilia, pale brown, interrupted by blackish and whitish dots. Hindwings, broadly spathulate; apex and termen, rounded; fuscous; cilia, pale ochreous, becoming fuscous on dorsum.

No doubt this species is variable, but it cannot be the same as *J. rubiginosa*, for, apart from the differences in colour and markings, the wings are differently shaped. In that species the ratio of breadth to length of forewing is 1 to 3, in this 1 to 2.

Derwent Bridge, in February; one specimen received from Mr. G. M. Goldfinch, who has the type.

Jeana robiginosa, n. sp.

robiginosus, rusty.

♂. 34 mm. Head and palpi, fuscous. Antennae, pale brownish; pectinations in male, 2½, each with a long terminal bristle. Thorax, fuscous; tips of hairs, whitish; some reddish hairs in middle. Abdomen and legs, fuscous. Forewings, elongate-triangular; costa, nearly straight; apex, rectangular; termen, rounded, slightly oblique; ferruginous-reddish, with grey strigulations mixed with whitish; near base, mostly grey; towards dorsum, mostly grey-whitish; a small fuscous, apical suffusion; two long, parallel, whitish strigulae before middle part of termen cilia, fuscous, mixed with reddish and barred with whitish. Hindwings, narrowly spathulate; apex and termen, rounded; fuscous; cilia, whitish-ochreous.

Waratah, in February; one specimen.

NEW LOCALITY RECORDS

These are numerous. It has become evident that a large number of species are generally distributed throughout the island, or generally distributed at lower or higher elevations. We are now able to make a commencement in designating these species, and in

their case further locality records will be more cumbrous than useful. Species of general distribution should be found in all localities, except (1) high mountain tops, (2) country in which the native flora is poorly represented, (3) areas which have been extensively cleared of native vegetation.

As the range of many species depends on altitude, this should be written on their locality labels if over 1000 feet. It is not necessary to indicate variations less than 500 feet. Only a conventional line can be drawn between low and high altitudes; I suggest that this, in Tasmania, should be 1000 feet, with the proviso that on the West Coast (no doubt for climatic reasons) some usually high-level species may sometimes descend to near sea level. The line suggested may be employed to divide roughly Hobart from Mt. Wellington. The species I have recorded from 1500 feet were taken at "Fern Tree," those at 2500 feet near "The Springs," those at 4000 feet on the "Ploughed Field."

The species formerly recorded as from Moina (the nearest township) were actually taken at a higher level, "Daisy Dell," on the Cradle Mountain-road. I now record them as from Cradle Mountain 2000 feet.

LYCAENIDAE

Candalides acasta Cox, Tasman Penin.

Zizina labradus Godart, Burnie, Scottsdale. Probably generally distributed at lower levels.

Neolucia agricola Westw., Tasman Penin., Beaconsfield, Derwent Bridge. Generally distributed.

Neolucia hobartensis Misk., Derwent Bridge. Generally distributed at higher levels.

Neolucia mathewi Misk., Launceston.

NYMPHALIDAE

Heteronympha merope Fab., Mt. Wellington (1500-2500 feet), Tasman Penin., St. Marys, Derby. Generally distributed.

Heteronympha philerope Bdv., Mt. Wellington (1500 feet), Scottsdale, Deloraine, Waratah. Generally distributed.

Heteronympha cordace Hb., Derwent Bridge, Weldborough.

Xenica klugi Guerin., Mt. Wellington (1500-2500 feet), Tasman Penin., St. Marys, Weldborough, Derby, Scottsdale, Railton. Generally distributed.

Oreixenica lathoniella Westw., Mt. Wellington (1500-2500 feet), Waratah. Generally distributed.

Precis villida Fab., Hobart, Conara, St. Marys, St. Helens. Generally distributed at lower levels.

Pyrameis cardui Lin., Hobart, Derwent Bridge, Waratah, Cradle Mt. (2000-3000 feet). Generally distributed.

Pyrameis itea Fab., Ouse, Cradle Mt. (2000-3000 feet). Generally distributed.

HESPERIDAE

Anisynta tasmanica Misk., Derwent Br. Probably generally distributed.

Hesperilla donnysa Hew., Mt. Wellington (2500 feet), Tasman Penin., Bruni I. Generally distributed.

Motasingha dominula Ploetz, Derwent Br.

Taractrocera papyria Bdv., Huon.

Ocybadistis walkeri Heron, Burnie.

LARENTIADAE

Euchoeca rubropunctaria Dbld., Weldborough, Derby, Deloraine, Rosebery. Generally distributed.
Poecilasthena pulchraria Dbld., Derwent Br., Weldborough, Rosebery. Generally distributed.
Poecilasthena urarcha Meyr., Waratah.
Poecilasthena euphylla Meyr., Derwent Br.
Poecilasthena anthodes Meyr., Hobart, Scottsdale.
Chloroclystis testulata Gn., Waratah.
Chloroclystis catastreptes Meyr., St. Helens.
Chloroclystis filata Gn., Coles Bay, Triabunna. Generally distributed.
Microdes squamulata Gn., St. Marys, Derwent Br.
Chaetolopha leucophragma Meyr., Mt. Wellington (1500 feet), St. Helens, Derwent Br., Waratah. Generally distributed.
Eccymatoge callizona Low., Mt. Wellington (1500 feet).
Horisme leucophanes Meyr., Russell Falls, Scottsdale, Derwent Br., Waratah. Generally distributed.
Cidaria subochraria Dbld., Mt. Wellington (2500 feet), Derwent Br., Waratah, Burnie, Cradle Mt. (2000 feet). Generally distributed.
Cidaria uncinata Gn., Mt. Wellington (2500 feet), Coles Bay. Generally distributed.
Larentia epicrossa Meyr., Derwent Br. Generally distributed.
Epirrhoe callima Turn., Derwent Br.
Epirrhoe eustropha Turn., Waratah.
Melitulias glandulata Gn., Derwent Bridge. Generally distributed.
Euphyia epicteta Turn., Mt. Wellington (1500 feet), Scottsdale, Weldborough, Derby, Deloraine, Waratah, Derwent Bridge. Generally distributed.
Euphyia interruptata Gn., Waratah, Mt. Barrow.
Euphyia lucidulata Wlk., Derwent Br., Scottsdale. Generally distributed.
Euphyia conifasciata Butl., Derwent Br., Waratah, Derby, Burnie. Generally distributed.
Euphyia psarodes Turn., Mt. Wellington (4000 feet).
Euphyia lamprotis Meyr., Rosebery.
Euphyia anthracinata Gn., Derwent Br., Queenstown, Rosebery, Waratah. Generally distributed.
Euphyia strumosata Gn., Mt. Wellington (1500 feet), Tasman Pen., St. Marys, St. Helens, Weldborough, Derby. Generally distributed.
Euphyia heteroleuca Meyr., Mt. Wellington (1500-2500 feet), Strahan.
Euphyia vacuaria Gn., Strahan.
Euphyia leptophrica Turn., Waratah.
Euphyia perornata Wlk., Derwent Br., Waratah. Generally distributed.
Euphyia ebuleata Gn., Derwent Br. Generally distributed.
Euphyia correlata Wlk., Weldborough.
Euphyia severata Gn., Derwent Br. Generally distributed.
Acodia pauper Rosen., Scottsdale, Waratah, Strahan. Generally distributed.
Xanthorhoe heliacaria Gn., Derwent Br., Waratah, Cradle Mt. (3000 feet).
Xanthorhoe vicissata Gn., Waratah, Mt. Barrow. Generally distributed.
Xanthorhoe brujata Gn., Hobart, Russell Falls, Strahan. Generally distributed.
Xanthorhoe controneura Meyr., Mt. Wellington (1500-2500 feet), Derwent Br., Waratah, Strahan, Cradle Mt. (3000 feet). Generally distributed.
Xanthorhoe subidaria Gn., Scottsdale, Derby, Deloraine. Generally distributed.
Dasyuris polycarpa Meyr., Mt. Wellington (4000 feet).

STERRHIDAE

Eois albicostata Wlk., Tasman Penin.
Eois halmaea Meyr., Weldborough, Scottsdale. Generally distributed.
Eois philocosma Meyr., Burnie, Waratah, Rosebery, St. Marys, Coles Bay, Derby. Generally distributed.
Scopula perlata Wlk., Hobart, Strahan, St. Marys, Weldborough, Scottsdale, Waratah. Generally distributed.

Scopula liotis Meyr., Mt. Wellington (2500 feet).
Scopula rubraria Dbld. Generally distributed.
Scopula optivata Wlk., Waratah, St. Marys, Scottsdale.

GEOMETRIDAE

Euloxia gratiosata Gn., Cradle Mt. (2000-3000 feet), Derwent Br.
Euloxia meandraria Gn., Derby, Scottsdale, Launceston, Waratah, Strahan, Mole Creek. Generally distributed.
Euloxia leucochorda Meyr., Mt. Wellington (2500 feet), Mt. Barrow, Weldborough.
Iulops argocrana Meyr., Weldborough.
Chlorocoma cadmaria Gn., Waratah, Derby, St. Helens. Generally distributed.
Chlorocoma dichloraria Gn., Weldborough, Derby, Deloraine, Russell Falls, Triabunna, Coles Bay, Derwent Br., Waratah. Generally distributed.
Chlorocoma rhodothrix Turn., Rosebery.
Gelasma semicrocea Wlk., Mt. Wellington (1500 feet), Derwent Br. Generally distributed.
Gelasma calaina Turn., Mt. Barrow.
Gelasma centrophlylla Meyr., Burnie, Strahan, St. Helens. Generally distributed.
Chlorodes boisduvalaria Gn., Scottsdale, St. Helens. Generally distributed.
Crypsiphona occultaria Don., Herrick, Coles Bay. Generally distributed.

BOARMIADAE

Diastictis australiaria Gn., Coles Bay, Derby, Scottsdale. Generally distributed.
Ectropis fractaria Gn., Mt. Wellington (1500 feet), Derwent Br., Strahan, Scottsdale. Generally distributed.
Ectropis despicata Wlk., Russell Falls.
Ectropis exsuperata Wlk., Coles Bay.
Psilosticha integraria Wlk., XXI., p. 420 (*mactaria* Meyr., nec. Gn.), Coles Bay.
Boarmia epiphloea Turn., Mt. Wellington (2500 feet), Rosebery, Derwent Br.
Boarmia lyciaria Gn., Russell Falls.
Syneora mundifera Wlk., Coles Bay, Scottsdale.
Syneora symphonica Turn., St. Helens, Scottsdale.
Lyelliana pristina Turn., Mt. Wellington (2500 feet), Russell Falls, Derwent Br., Waratah, Mt. Barrow.
Metrocampa biplaga Wlk., Weldborough.
Metrocampa ada Butl., Russell Falls, Rosebery, Waratah, Weldborough, Mt. Barrow. Generally distributed.
Casbia alphitopis Turn., Mt. Wellington (1500 feet).
Casbia eccentritis Meyr., Mt. Wellington (1500 feet), Mt. Barrow. Generally distributed.
Amelora crenulata Turn., Mt. Wellington (1500 feet), Strahan, Rosebery. Generally distributed.
Amelora cyclocentra Turn., Mt. Wellington (2500 feet), Derwent Br., Cradle Mt. (3000 feet).
Amelora suffusa Turn., Mt. Wellington (2500 feet).
Amelora leucaniata Gn., Derwent Br., Strahan, Waratah, Cradle Mt. (3000 feet).
Amelora oritropha Turn., Derwent Br.
Mnesampela privata Gn., Derwent Br.
Mictodoca tozeuta Meyr., Coles Bay, Derwent Br.
Thalaina selenaea Dbld., Coles Bay.
Thalaina inscripta Wlk., Russell Falls, St. Marys, Derwent Br. Generally distributed.
Conosara castaneata Meyr., Russell Falls.
Chlenias banksiaria Le Guil., Waratah.
Chlenias zonaea Meyr., Russell Falls.
Archephanes zalosema Turn., Mt. Wellington (2500-4000 feet), Derwent Br.
Hypsitropha euschema Turn., Derwent Br., Strahan, Rosebery.
Drymoptila temenitis Meyr., Strahan.

OENOCHROMIDAE

Taxeotis intextata Gn., Launceston.
Taxeotis oraula Meyr., Hobart, Mt. Wellington (1500-2500 feet), Coles Bay, Derwent Br., Hellyer Gorge, Wilmot. Generally distributed.
Dichromodes stilbiata Gn., St. Helens, Derwent Br. Generally distributed.
Adeixis inostentata Derwent Br.

NOTODONTIDAE

Teara periblepta Turn., Rosebery, Derwent Br.
Gallaba eugraphes Turn., Mt. Wellington (2500 feet).

ARCTIADAE

Thermeola tasmanica Hmps., Mt. Wellington (1500-2500 feet). The locality Hobart may be an error.
Scoliacma bicolor Bdv., Hobart.
Phaeophebosia furcifera Wlk., Waratah.
Palaeosia bicosta Wlk., Coles Bay, Weldborough, Deloraine, Waratah. Generally distributed.
Halone sejuncta Feld., St. Helens, Derby, Burnie.
Caprimima sicciodes Hmps., Rosebery, Waratah.
Caprimima procrena Meyr. Generally distributed.
Thallarcha epiostola, Stanley.
Castulo doubledayi Newm., Russell Falls, Coles Bay, Derby, Wilmot. Generally distributed.
Ardices glatignyi Le Guil., Mt. Wellington, Rosebery, Strahan, Waratah.
Ardices curvata Don. subsp. *vigens* Butl. I., Georgetown.

NOLIDAE

Celama tholera Turn., Burnie.
Celama albalis Wlk., Derwent Br.
Celama paromoea Meyr., Waratah.
Nola cycota Meyr., Coles Bay, St. Marys, Queenstown, Derwent Br.
Nola aulocota Meyr., Mt. Wellington (2500 feet).
Nola macrorrhyncha Turn., Mt. Wellington (1500 feet), Weldborough, Mt. Barrow, Waratah.
Roeselia lugens Wlk., Russell Falls, Waratah.

NOCTUIDAE.

AGARISTINAE.

Phalaenoides glycinae Lew., Hobart, Beaconsfield.
Phalaenoides tristifica Hb., Strahan.
Hecatesia fenestrata Bdv., Hobart, Rosebery.

AGROTINAE.

Euxoa porphyricollis Gn., Waratah, Cradle Mt. (3000 feet).

MELANCHRINAE.

Sideridis ewingii Westw., Mt. Wellington (2500 feet), Deloraine, Cradle Mt. (3000 feet).
Dasygaster hollandiae Gn., Mt. Wellington (2500 feet), Waratah, Devonport.

CUCULLIANAE.

Eumichtis saliaris Gn., Waratah. Generally distributed.

ACRONYTINAE.

Euplexia iorrhoa Meyr., Mt. Wellington (1500-2500 feet).
Euplexia nigerrima Gn., Mt. Wellington (2500 feet).
Amphipyra sanguinipuncta Gn., Mt. Wellington (1500 feet), Burnie.
Caradrina capularis Gn. Weldborough, Derby, Scottsdale.

NOCTUINAE.

Alapadna pauropis Turn., Weldborough, Derby.
Artigisa lignicolaria Wlk., Rosebery, Strahan, Derwent Br.
Rhodina falculalis Gn., Hobart, Tasman Penin.

LYMANTRIADAE

Acyphas leucomelas Wlk., Burnie.

ANTHELIDAE

Anthela connexa Wlk., Rosebery, Scottsdale, Cradoc.

ZYGAENIDAE

Pollanisus lithopastus Turn., Derwent Br., St. Marys, Waratah.
Pollanisus viridipulverulentus Guer., Derwent Br.
Neoprocris dolens Wlk., Derwent Br., Derby.

PHYCITIDAE

Homoeosema fornacella Meyr., Derwent Br.
Unadilla distichella Meyr., Burnie.
Sclerobia tritalis Wlk., Launceston, Railton, Deloraine, St. Marys, Derby. Generally distributed at lower levels.

GALLERIADAE

Heteromicta pachytera Meyr., Launceston.

CRAMBIDAE

Platytes pentadactyla Zel., Waratah.
Chilo lativittalis Wlk., Tasman Penin., Derwent Br.
Talis relatalis Wlk., Tasman Penin., Scottsdale. Generally distributed.
Talis orthotypa Turn., Derwent Br.
Talis epulentella Zel., Mt. Wellington (2500 feet), Russell Falls.
Talis grammella Zel., Waratah, Weldborough, Derby. Generally distributed.

SCHOENOBIADAE

Scirpophaga patulella Wlk., Tasman Penin., Weldborough, Derby, Scottsdale, Waratah. Generally distributed.

PYRALIDAE

Diplopseustis perieresalis Wlk., Hobart, Mt. Wellington (2500 feet), Scottsdale, St. Helens, Strahan.
Spcetratrota fimbrialis Warr., Tasman Penin., Beaconsfield, Coles Bay.
Macalla marmorea Warr., Launceston, Deloraine, Coles Bay, Penguin, Derwent Br.
Epipaschia amauropis Turn., Mt. Wellington (1500 feet), Derwent Br., Rosebery, Burnie, Wilmot, Scottsdale. Generally distributed.
Epipaschia costigeralis Wlk., Mt. Wellington (2500 feet).

PYRAUSTIDAE

Hydreuretis oxygramma Turn., Deloraine.
Nymphula nitens Butl., Deloraine.
Musotima nitidalis Wlk., Burnie, Queenstown, Derby, Scottsdale.
Nacoleia rhoeonalis Wlk., St. Marys, Derby.

Hellula undalis Gn., Hobart.
Metasia liophaea Meyr., Hobart, St. Marys.
Metasia capnochroa Meyr., Rosebery.
Pyrausta hyalistis Low., Weldborough.
Heliothela persumptana Wlk., Hobart.
Eclipsiodes drosera Meyr., Hobart, Strahan, Derwent Br., Waratah.
Scoparia favilliferella Wlk., Tasman Pen., Derwent Br., Waratah. Generally distributed.
Scoparia philonephes Meyr., Derwent Br., Cradle Mt. (3000 feet), Mt. Barrow.
Scoparia cleodoralis Wlk., Waratah, Weldborough. Generally distributed.
Scoparia syntaracta Meyr., Waratah. Generally distributed.
Scoparia spelaea Meyr., Mt. Wellington (2500 feet), Tasman Pen., Waratah. Generally distributed.
Scoparia gomphota Meyr., Mt. Wellington (2500 feet).
Scoparia anthracias Meyr., Queenstown, Derwent Br. Generally distributed.
Scoparia plagiotis Meyr., Mt. Wellington (1500-2500 feet), King R. Gorge, Waratah, Mt. Barrow. Generally distributed.

PTEROPHORIDAE

Platyptilia omissalis Fletcher, Hobart, St. Marys, Launceston. Generally distributed.
Platyptilia phaeonephes Meyr., Waratah.

PHALONIADAE

Heliocosma incongruana Wlk., St. Marys, Weldborough. Generally distributed.

TORTICIDAE

Proselena annosana Meyr., Hobart, Stanley.
Acropolitis rudis Wlk., Stanley.
Isochorista chaodes Meyr., Derwent Br.
Batodes conjunctana Wlk., Derby.
Capua poliobaphes Turn., Tasman Pen., St. Marys, Scottsdale, Burnie, Wilmot. Generally distributed.
Capua euphona Meyr., Tasman Pen., Derwent Br. Generally distributed.
Capua eugrapta Turn., Tasman Pen.
Capua nimbosa Turn., Hobart.
Capua clarana Meyr., Tasman Pen., Coles Bay, St. Marys, Derwent Br. Generally distributed.
Capua montivagana Meyr., St. Marys. Generally distributed.
Capua mersana Wlk., Derby, Rosebery. Generally distributed.
Capua intractana Wlk., Mt. Wellington (2500 feet), Tasman Pen., Derby, Scottsdale, Burnie. Generally distributed.
Capua placoxantha Low, Weldborough.
Cacoecia polygraphana Wlk., Tasman Pen., Coles Bay, Rosebery. Generally distributed.
Tortrix xylodes Meyr., Waratah. Generally distributed.
Tortrix ashworthana Newm., Derby, Waratah.
Tortrix psapharana Meyr., Strahan, Waratah, Burnie.
Tortrix postvittana Wlk., Waratah. Generally distributed.
Tortrix caryotis Meyr., Hobart, Derwent Br., Waratah, Cradle Mt. (3000 feet). Generally distributed.
Tortrix eurystropha Turn., Mt. Wellington, Strahan, Waratah.
Tortrix incompta Turn., Waratah.
Tortrix ophiodesma Low, Mt. Wellington (1500-2500 feet), Rosebery.
Tortrix fabricata Meyr., Mt. Wellington (2500 feet), Rosebery.
Tortrix sobriana Wlk., Scottsdale.
Tortrix plastica Meyr., Waratah. Generally distributed.
Tortrix astathmeta Turn., Waratah.

Tortrix lythrodana Meyr., Derwent Br. Generally distributed.
Tortrix laganodes Meyr., Mt. Wellington (1500 feet).
Tortrix stigmatias Meyr., Mt. Wellington (2500 feet), Weldborough.
Tortrix psarodes Meyr., Mt. Wellington (3000 feet).
Tortrix subfurcatana Wlk., Tasman Pen., Weldborough, Derby, Waratah. Generally distributed.
Tortrix tasmaniana Wlk., Tasman Pen.
Tortrix eucela Meyr., Mt. Wellington (2500 feet).
Tortrix liquidana Meyr., Mt. Wellington (2500 feet), Tasman Pen., St. Marys, Derwent Br., Waratah. Generally distributed.
Tortrix indigestana Meyr., Tasman Pen.
Tortrix concordana Meyr., St. Marys.
Tortrix concolorana Meyr., Mt. Wellington (2500 feet), St. Marys, Weldborough.
Tortrix divulsana Wlk., Waratah. Generally distributed.
Epichorista serena Meyr., Pt. Davey.
Cnephasia contortula Turn., Mt. Wellington (2500 feet).
Cnephasia gnophodryas Low, Mt. Wellington (1500-4000 feet), Strahan, Waratah.
Scolioplecta comptana Wlk., Coles Bay. Generally distributed.

EUCOSMIDAE

Spilonota ejectana Wlk., Tasman Pen., Herrick, Derby, Railton. Generally distributed.
Spilonota macropetana Meyr., Triabunna.
Acroclita fidana Meyr., Derwent Br.
Acroclita perspectana Wlk., Tasman Pen., Strahan.
Eucosma triangulana Meyr., Mt. Wellington (1500-2500 feet).

ELACHISTIDAE

Labdia semnostola Meyr., Strahan.
Hoplophanes phaeochalca Meyr., Rosebery, Strahan.
Coleophora deauratella Zel., Mt. Wellington (2500 feet), St. Marys, St. Helens, Devonport. Generally distributed.

GELECHIADAE

Megacraspedus niphodes Low, Waratah.
Megacraspedus popularis Meyr., Derwent Br.
Aristotelia furtiva Meyr., Coles Bay.
Aristotelia centrosema Low, Burnie.
Thiotricha parthenica Meyr., Deloraine, Derby.
Phthorinaea operculella Zel., Derby.
Epimimastis porphyroloma Low, Derwent Br.
Crocanthes glycina Meyr., Tasman Pen., Coles Bay.
Hyodectis crenoides Meyr., Rosebery.

XYLORYCTIDAE

Xylorycta parabolella Meyr., Derwent Br.
Xylorycta argentella Wlk., Tasman Pen.
Agriophara diminuta Rosen., Hobart.
Agriophara cinerosa Rosen., Derwent Br., Brunie.

OECOPHORIDAE

Endrosis lactella Schif., Waratah. Generally distributed.
Borkhausenia oxypeuces Turn., Coles Bay.
Borkhausenia canephora Meyr., Queenstown, Waratah. Generally distributed.
Borkhausenia anthemodes Meyr., Mt. Wellington (2500 feet), Derwent Br., Strahan.
Locheutis philochlora Meyr., Mt. Wellington (1500 feet), Rosebery, Waratah, Cradle Mt. (3000 feet).

Locheutis dolichotricha Turn., Mt. Wellington (1500-2500 feet).
Trachypepla capsellata Meyr., Hobart, Mt. Wellington (1500 feet), St. Marys, St. Helens. Generally distributed.
Eucryphaea phoenochyta Turn., Rosebery, Cradle Mt. (3000 feet).
Barea arbitra Meyr., Hobart, Mt. Wellington (1500-2500 feet), Russell Falls, Derwent Br., Gordon R. Generally distributed.
Barea asbolaea Meyr., Mt. Wellington (1500 feet), Scottsdale, Waratah. Generally distributed.
Barea hyperarcha Meyr., Mt. Wellington (1500-2500 feet), Scottsdale, Coles Bay.
Barea micropis Meyr., Mt. Wellington (1500 feet), St. Marys.
Barea pslogramma Turn., Tasman Pen., Mt. Barrow.
Barea psephophora Meyr., Derwent Br., Strahan, Rosebery. Generally distributed.
Barea epithistis Meyr., Triabunna, Scottsdale, Devonport. Generally distributed.
Eulechria habrophanes Meyr., Hobart.
Eulechria poecilella Meyr., Triabunna.
Eulechria xylopterella Meyr., St. Helens.
Eulechria aerodes Meyr., Launceston.
Eulechria hemiphanes Meyr., Beaconsfield.
Eulechria sthenopis Turn., Mt. Wellington (1500-2500 feet), Strahan, Rosebery, Waratah, Scottsdale, Weldborough. Generally distributed.
Eulechria mesophragma Meyr., St. Marys.
Eulechria adoxella Meyr., Bothwell, Strahan.
Eulechria pastea Turn., Burnie, Cradle Mt. (3000 feet).
Machima leucerythra Meyr., Hobart, Russell Falls, Railton. Generally distributed.
Machimia miltopsara Turn., Mt. Wellington (1500 feet).
Machaeretis pelinopa Meyr., Derwent Br., Burnie, Weldborough.
Machaeretis aegrella Meyr., Derwent Br. Generally distributed.
Machaeretis psathyra Meyr., Mt. Wellington (1500 feet).
Haplodyta thoracta Meyr., Tasman Pen., Derwent Br.
Ocystola crystallina Meyr., Railton.
Oxythecta nephelonota Meyr., Waratah, Derwent Br. Generally distributed.
Deuterogonia acroxantha Meyr., Mt. Wellington (2500 feet), Derwent Br. Generally distributed.
Aristeis chrysoteuches Meyr., Hobart, Mt. Wellington (1500 feet).
Coesyra stenoptera Meyr., St. Marys.
Coesyra parvula Meyr., Rosebery. Generally distributed.
Coesyra ophthalmica Meyr., St. Marys, Weldborough.
Coesyra anthodora Meyr., Strahan.
Coesyra ochrocirrha Turn., Gordon R.
Coesyra aclea Meyr., Rosebery. Generally distributed.
Pleurota chlorochyta Meyr., Tasman Pen., St. Marys, Derwent Br. Generally distributed.
Pleurota endesma Meyr., Mt. Wellington (1500-2500 feet), Scottsdale, Weldborough, Strahan, Waratah, Burnie. Generally distributed.
Pleurota themeropis Meyr., Deloraine.
Pleurota psephena Meyr., Gordon R., Waratah.
Opsitycha squalidella Meyr., Tasman Pen.
Thalerotricha mylicella Meyr., Hobart.
Philobota auriceps Butl. It is doubtful whether this species occurs in Tasmania. Most, and perhaps all, former records should, I think, be referred to *P. chrysosticha*, which is here described.
Philobota olympias Meyr., Launceston.
Philobota atmobola Meyr., Tasman Pen., St. Marys, Waratah. Generally distributed.
Philobota aeolias Meyr., Weldborough, Waratah.
Philobota charaxias Meyer., Hobart, Mt. Wellington (1500-2500 feet), Tasman Pen.
Philobota placochorda Turn., Waratah.
Philobota aurinatella, Derwent Br.
Philobota cirrhodes Meyr., Derby.

Philobota ceratina Meyr., Mt. Wellington (1500-2500 feet).
Chrysonoma atricollis Meyr., Hobart.
Chezala glaphyropla Meyr., Coles Bay.
Enchronista bathrosticha Turn., Mt. Wellington (1500 feet), Cradle Mt. (3000 feet).
Zonopetala erythrosema Meyr., St. Marys.
Zonopetala quadripustulella Wlk., Hobart.
Heliocausta elaeodes Meyr., Derwent Br.
Heliocausta coenosa Meyr., Russell Falls.
Lepidotarsa chrysopoca Meyr., Rosebery, Herrick.
Tortricopsis uncinella Zel., Weldborough, Scottsdale. Generally distributed.
Thudaca trabeata Wlk., Tasman Pen., Derwent Br. Generally distributed.
Thudaca obliquella Wlk., Derwent Br. Generally distributed.
Thudaca innubila Turn., Derwent Br.
Eutorna leptographa Meyr., Hobart, St. Marys, Weldborough, Burnie. Generally distributed.
Eutorna eurygramma Meyr., Rosebery, Weldborough.
Eutorna diaula Meyr., Hobart, Queenstown, Burnie. Generally distributed.
Cryptolechia lewinella Newn., Hobart.
Cryptolechia radiosella Wlk., Hobart.
Cryptolechia lutea Turn., Strahan, Stanley.
Cryptolechia argillea Turn., St. Marys, Weldborough, Beaconsfield, Railton.

HELIODINIDAE

Stathmopoda cephalaea Meyr., Mt. Wellington (1500 feet). Larvae feeding in galls on *Acacia decurrens* and on another unidentified species of *Acacia*. Triabunna.

GLYPHIPTERYGIDAE

Cebysa leucoteles Wlk., Richmond.
Choreutis lampadias Meyr., Mt. Wellington (2500-4000 feet), Derwent Br., Waratah.
Choreutis homotypa Meyr., Mt. Wellington (2500 feet), Derwent Br.
Glyphipteryx macraula Meyr., Hobart, Mt. Wellington (2500 feet), Burnie.
Glyphipteryx tetrasema Meyr., Mt. Wellington (2500 feet), Derwent Br.
Glyphipteryx asteriella Meyr., Waratah.
Glyphipteryx calliscopa Low, Rosebery, Waratah.
Glyphipteryx leucargyra Turn., Tasman Pen., Strahan.
Glyphipteryx gypsonota Turn., Tasman Pen., Strahan, Cradle Mt. (3000 feet).

HYPONOMEUTIDAE

Zelleria mystarcha Meyr., Mt. Wellington (2500 feet).
Zelleria citrina Meyr., Queenstown, Rosebery.

COPROMORPHIDAE

Hypertropha tortriciformis Gn., Coles Bay, Derwent Br.

CARPOSINIDAE

Bondia nigella Newm., Mt. Wellington.
Carposina petraea Meyr., Mt. Wellington (2500 feet).
Paramorpha semotheta Meyr., Derwent Br.

PLUTELLIDAE

Phalangitis tumultuosa Meyr., Weldborough.

ERECHTHIADAE

Leucoptera chalchocycla Meyr., Mt. Wellington (2000-2500 feet), Launceston, Burnie.
Leucoptera deltidias Meyr., Hobart, Mt. Wellington (2500 feet), Waratah.
Opogona comptella Wlk., Mole Creek. Generally distributed.
Opogona stereodyta Meyr., Derwent Br., Rosebery. Generally distributed.
Dascia sagittifera Meyr., St. Helens.

TINEIDAE

Narycia adelopis Meyr., Hobart.
Narycia phaulodes Meyr. (erroneously given as *phauloptera* in the first revision). Hobart.
Narycia retinochra Low, Deloraine. Generally distributed.
Mesopherna palustris Meyr., Hobart.
Lindeera tessellatella Blanch., Hobart.
Monopis ethelella Newn., Waratah, Cradle Mt. (3000 feet). Generally distributed.
Tinea irruptella Wlk., Derwent Br.
Tinea ochranthes Meyr., Coles Bay, Beaconsfield.

ADELIDAE

Nemotois sparsella Wlk., St. Marys, Derwent Br.

Tasmanian Parastacidae

By

Ellen Clark

(Read 14 November, 1938)

Plates XII-XIII

Freshwater and land crayfishes of the family Parastacidae are found in most countries of the Southern Hemisphere. They occur abundantly throughout Tasmania, eleven species, contained in four genera, being known. In the following pages each of these is described and figured, making a complete list of the Tasmanian members of the family.

The genus *Astacopsis*, which includes the largest known species, is aquatic, each of the three species inhabiting both rivers and lakes, *A. tricornis* Clark being known only from the Lake St. Clair district.

It is interesting to find specimens of *Geocharax*, a semi-aquatic genus found throughout Victoria and on Kangaroo Island, occurring at Smithton on the north coast. The closely allied, semi-aquatic genus *Cherax* has not been found in Tasmania, although it is found abundantly in each State on the mainland of Australia, in New Guinea and in the Aru Islands.

Four species of the land-dwelling crayfishes *Engaeus* are found in the northern half of the island, but none has been found in the southern half. Several species of the genus occur in Victoria and one on King Island.

Parastacoides, a land-dwelling genus containing three species, is found in the extreme south-west of the island and on the south and west coasts.

The distribution of the various genera and species cannot be mapped out satisfactorily at present. Comparatively little collecting has been done with this family, particularly in the southern half of the island. The material collected by the recently-formed

Tasmanian Biological Survey, however, has enabled me to record specimens from many additional localities, and undoubtedly further collecting will add considerably to our knowledge of the distribution of these animals.

My research work on this group, which was carried out at the National Museum, Melbourne, was made possible by a grant from the trustees of the Commonwealth Research and Endowment Fund.

Genus **Geocharax** Clark

Geocharax Clark, *Mem. Nat. Mus. Vict.*, 10, 1936, p. 31.

Carapace higher than broad, punctate or tuberculate. Cervical groove deeply impressed, rounded. Rostral carinae smooth. Abdomen smooth, punctate, or setose; lateral margins rounded. Stem of each podobranch laterally produced into a small wing-like expansion bearing a few hooked filaments. Gill formula 21 + ep.r.

Geocharax gracilis Clark

Pl. XII, figs. 1, 1a, 1b

Geocharax gracilis Clark, *Mem. Nat. Mus. Vict.*, 10, 1936, p. 31, pl. vi., fig. 26.

The rostrum is long and slender; the lateral carinae very sharp; and the interantennal spine short and broad, sharply pointed. The sternal keel is slender and sharp. The pereopods are very slender, and the great chelae short and slender. Length of adult specimens 63 mm.

Three specimens from Smithton, collected by Miss J. Fenton, and one specimen from a shallow stream near Smithton, collected by J. W. Evans. This species is found also in the Gellibrand River, south of Colac, Victoria (type locality) (W. F. Hill); Portland, Victoria (L. R. Kurtze); and on Kangaroo Island, South Australia (South Australian Museum).

Genus **Astacopsis** Huxley

Astacus, Gray, *Eyre's Journ. Exped. Disc. Centrl. Austrl.*, i, (Appendix), 1845, p. 409; von Martens, *Monatsber. Akad. Wiss. Berlin*, 1868, p. 615.

Astacopsis, Huxley, *Proc. Zool. Soc. Lond.*, 1878, p. 764; Smith, *Trans. Linn. Soc. Lond.*, ser. 3, xi., 1908, Zool., p. 70; Haswell, *Cat. Austrl. Mus., Crust.*, 1882, p. 175; Smith, *Proc. Zool. Soc. Lond.*, 1912, p. 154; Faxon, *Proc. U.S. Nat. Mus.*, xx., 1898, p. 639; Faxon, *Mem. Mus. Comp. Zool.*, xl., 8, 1914, p. 402; Clark, *Mem. Nat. Mus. Vict.*, 10, 1936, p. 33.

Carapace with numerous small tubercles and punctures. Cervical groove deeply impressed, rounded. Rostrum broad, carinae blunt, tuberculate. Abdomen smooth, or punctate, lateral margins pointed,

usually with spines on lateral margins of only the first and second segments. First segment with lateral lobes large and rounded. Stems of podobranchs without broad wing-like expansions. Gill formula 21 + ep.r.

Astacopsis franklinii (Gray)

Pl. XII, figs. 2, 2a, 2b

Astacus franklinii Gray, *Eyre's Journ. Exped. Disc. Cent. Austrl.*, i. (Appendix), 1845, p. 409, t. 3, f. 1; Erichson, *Arch. f. Naturg.*, xii., 1846, p. 375; White, *List Crust. Brit. Mus.*, 1847, p. 72; von Martens, *Monats. Akad. Wiss. Berlin*, 1868, p. 616.

Astacopsis franklinii, Haswell, *Cat. Austrl. Mus., Crust.*, 1882, p. 176; Thomson, *Pap. Roy. Soc. Tas.*, 1892 (1893), p. 50; Faxon, *Proc. U.S. Nat. Mus.*, xx., p. 669, 1898; Ortmann, *Proc. Amer. Philos. Soc.*, xli., p. 292, 1902; Faxon, *Mem. Mus. Comp. Zool.*, xl., 8, 1914, p. 402; Clark, *Mem. Nat. Mus. Vict.*, 10, 1936, p. 34, pl. vii., fig. 27.

The rostrum is broad, the carinae blunt, with several small tubercles. The squame of the second antennae with three to five small, sharp spines on the outer margin. The interantennal spine is long and broad, sharply pointed, with the lateral margins serrated. The branchiostegites and the anterior of the carapace are studded with numerous small tubercles. The great chelae are short and stout, the upper surface being covered with numerous small tubercles and punctures. Length of adult specimens 127 mm.

Habitat: Saundridge (A. Bartholomew); Hobart (V. Hickman).

Local Variety.

Several specimens from the Mt. Wellington district, received from the Tasmanian Biological Survey, differ from the typical *franklinii*, in having the squame of the second antennae smooth, and the upper surface of the great chelae less tuberculate.

Habitat: Hobart Creek, Mt. Wellington; Cascade Creek, Mt. Wellington (D. Turner); Ridgeway (D. Tagg).

Astacopsis gouldi Clark

Pl. XII, figs. 3, 3a, 3b

Astacus sp. Gould, *Pap. Roy. Soc. Tas.*, 1870 (1871), p. 42.

Astacopsis franklinii, Huxley, *Proc. Zool. Soc. Lond.*, 1878, p. 764; Smith, *Trans Linn. Lond.*, ser. 2, xi., Zool., p. 70, 1908; Smith, *A Naturalist in Tasmania*, 1909, p. 110, fig. 30; Smith, *Proc. Zool. Soc. Lond.*, p. 154, 1912, pl. xiv.

Astacopsis gouldi Clark, *Mem. Nat. Mus. Vict.*, 10, 1936, p. 35, pl. vii., fig. 28.

The rostrum is broad, the apex sharp, carinae rounded, each with three or four tubercles; there is a sharp, longitudinal carina in the centre of the rostrum continued backward from the apex about half-way to the base. The squame of each second antenna is

large and smooth. The interantennal spine is rather long and narrow, sharply pointed, the lateral margins being either smooth or serrated. The branchiostegites and the anterior of the carapace with a few small scattered tubercles. The great chelae are very stout, the apex of both the propodus and the dactylus being densely tuberculate or spinous.

Habitat: Circular Head (J. Leadbeater) (type locality); Zeehan; Gordon River; Brid and Muddy Creeks, Bridport; Macquarie Harbour; Wynyard.

This is the giant Tasmanian crayfish, adult specimens of which measure up to 405 mm. in length, measured from the tip of the rostrum to the end of the telson. The species may be recognised readily by the conspicuous longitudinal carina in the centre of the rostrum. Immature specimens, 127 mm. long, show every detail of the adult armature.

Astacopsis tricornis Clark

Pl. XII, figs. 4, 4a, 4b

Astacopsis tricornis Clark, *Mem. Nat. Mus. Vict.*, 10, 1936, pl. i, fig. 7; pl. vii., fig. 29.

Length of largest specimen 140 mm.

Rostrum broad, slightly longer than the breadth at base, carinae large and blunt, with four or five tubercles, apex of rostrum and carinae each produced into comparatively long, bluntly-pointed spines; a sharp spine and a small tubercle at base of carinae, with a large, rounded boss postero-laterally.

Eyes large. Squame of each second antenna reaching almost to end of third segment of second antennae, broad and sharply pointed. Interantennal spine short and broad, apex long and sharp, lateral margins serrated.

Carapace shorter than abdomen, broader than high, slightly more than twice as long as broad; cervical groove deeply impressed, branchio-cardiac grooves feeble; areola broad; surface of entire carapace densely punctate. Branchiostegites and anterior of carapace densely tuberculate.

Sternal keel slender; lateral processes erect, slender and sharp, posterior pair deeply grooved; a large, deep opening under lateral processes, largest on third and fourth pairs; processes between fourth pereopods long and stout.

First abdominal segment with a sharp spine on each lateral lobe; second segment with several sharp spines along lateral margins,

several tubercles and spines above the lateral spines; lateral margins of all following segments each produced to sharp points. One or two rows of small tubercles on dorso-lateral margins of each segment.

Telson one and one-third times as long as broad, with a spine on each lateral margin at posterior third. Uropods rounded, longer than telson, inner rami each divided by a feeble longitudinal median carina ending in a small spine near posterior margin; outer rami each with transverse suture at apical third, one large and several small, spines along the suture; lobes at base of uropods rounded, without spines.

Great chelae stout; propodus two and one-half times as long as broad, punctate, upper margin with several sharp spines, lower margin with two rows of blunt spines, three or four tubercles on both upper and lower surfaces near base of dactylus, cutting edge with two or three small tubercles; dactylus stout, with two rows of small, blunt spines on upper margin, cutting edge with two or three small tubercles, a row of small tubercles on upper surface, just above cutting edge. Carpus with one large, sharp spine and two or three small blunt spines on upper margin; merus with several sharp spines on upper margin.

Habitat: Lake St. Clair (B. Spencer) (type locality); Cradle Mountain; Lake St. Clair district, from a creek running into the Derwent River, one mile from Derwent Bridge (Handley); mouth of Cuvier River, Lake St. Clair (A. W. S. Powell).

As the type of this species is only 105 mm. in length, and larger specimens show several variations in character, due to size and age, the species has been redescribed and figured from a larger specimen taken from the Cuvier River, and received from the Tasmanian Biological Survey.

All the localities from which *A. tricornis* has been received are in the Lake St. Clair district or from the rivers leading from it; the altitude in this district is between 2000 feet and 3000 feet.

This is the most spinous of all the Tasmanian species; the abdomen of the largest specimens showing indications of rows of tubercles or spines, which suggest that larger specimens may be found with well-developed spines and tubercles on the abdomen similar to those in the species of *Euastacus*, occurring in the rivers of eastern Australia.

Great variation is shown in the armature of the series examined. The spines on the great chelae and carpus vary considerably, even on the same individual, and this applies also to the spines on the abdomen. Four of the specimens have a small spine near the centre of the outer margin of the squame of the second antennae.

Genus **Engaeus** Erichson

Astacus (*Engaeus*) Erichson, *Arch. f. Naturg.*, xii., 1846, p. 102.
Astacus, von Martens, *Monats. Akad. Wiss. Berlin*, p. 618, 1868.
Engaeus, Huxley, *Proc. Zool. Soc. Lond.*, 1878, p. 769; Haswell, *Cat. Austrl. Mus., Crust.*, p. 178, 1882; Faxon, *Proc. U.S. Nat. Mus.*, xx., 1898, p. 670; Faxon, *Mem. Mus. Comp. Zool.*, xl., 8, 1914, p. 403; Smith and Schuster, *Proc. Zool. Soc. Lond.*, 1913, p. 118; Clark, *Mem. Nat. Mus., Vict.*, 10, 1936, p. 37.

Carapace higher than broad, punctate or feebly tuberculate, cervical groove either feeble or moderately well impressed, somewhat V-shaped. Rostral carinae smooth or feebly tuberculate. Abdomen smooth, punctate or setose; lateral margins rounded. First segment without lateral lobes. Stems of podobranchs without wing-like expansions. Posterior pleurobranch usually well developed, sometimes rudimentary. Gill formula 21 + ep.r.

Engaeus cunicularius Erichson

Pl. XII, figs. 5, 5a, 5b

Astacus (*Engaeus*) *cunicularius* Erichson, *Arch. f. Naturg.*, xii., 1846, p. 102.
Astacus cunicularius Er., von Martens, *Monats. Akad. Wiss. Berlin*, 1868, p. 169.
Engaeus cunicularius Er., Haswell, *Cat. Austrl. Mus., Crust.*, 1882, p. 179; Thomson, *Pap. Roy. Soc. Tas.*, 1892 (1893), p. 50, pl. 1, figs, 1-2; Faxon, *Proc. U.S. Nat. Mus.*, xx., 1898, p. 676; Ortmann, *Proc. Amer. Phil. Soc.*, xli., 1902, p. 292; Smith and Schuster, *Proc. Zool. Soc. Lond.*, p. 124, 1913; Clark, *Mem. Nat. Mus. Vict.*, 10, 1936, p. 38, pl. viii., fig. 35.

The rostrum is broad, reaching to base of third segment of first antennae, the apex blunt; the carinae are sharp and carried well back on to the carapace. The squame of each second antenna is large and sharply pointed. The interantennal spine is triangular and bluntly pointed. The sternal keel is narrow and very sharp. The great chelae are slender, with a few feeble tubercles on the upper margin, and the lower margin smooth.

Habitat: Glenore, near Hagley (A. Bartholomew); Launceston (A. Bartholomew); Mundan Farm, Longford (A. Bartholomew); South Esk River, Longford, taken from the stomach of a brown trout (P. L. Andrews).

Engaeus leptorhynchus, sp. nov.

Pl. XIII, figs. 6, 6a, 6b

Length of largest specimen 40 mm.

Rostrum very slender, reaching to base of third segment of first antennae, apex sharp; carinae sharp, carried well back on to carapace.

Squame very long and slender, reaching almost to end of third segment of second antennae, terminal spine sharp. Interantennal spine short and broad, bluntly pointed. Exopods of third maxillipedes rudimentary.

Sternal keel broad, bluntly rounded, between first and third pereopods; first three pairs of lateral processes small and blunt, processes between third pereopods not flattened, deeply grooved, margins blunt; processes between fourth pereopods long and slender. There are no openings on any of the lateral processes.

Telson narrowly cone-shaped, without spines on the lateral margins, shorter than uropods; inner rami of uropods rounded, divided by a longitudinal median carina, tapering away at posterior margin; outer rami rounded, divided by a longitudinal median carina, ending in a sharp spine on the transverse suture, the transverse suture placed at the posterior third of uropod, several small sharp spines along the suture.

Great chelae short and stout, punctate and setose; propodus twice as long as broad, with a row of tubercles on upper margin, lower margin smooth, two or three small tubercles along cutting edge, a smooth carina on both upper and lower surface above cutting edge; dactylus slender, punctate and setose, with one or two small tubercles on cutting edge, two smooth carinae along upper margin, a smooth carina on both upper and lower surfaces above cutting edge. Carpus with numerous small tubercles on upper margin, upper margin of merus with a feebly tuberculate carina.

Posterior pleurobranch well developed.

Habitat: Pioneer Mine, Derby (A. Bartholomew) (type locality); Bradshaw's Creek, three miles from Herrick.

Types in the National Museum, Melbourne.

Near *E. cuniculariius* Er., in general appearance, but it may be separated readily by the slender rostrum and squame, the form of the sternal keel, and by the great chelae.

Engaeus fossor Erichson

Pl. XIII, figs. 7, 7a, 7b

Astacus (*Engaeus*) *fossor* Erichson, *Arch. f. Naturg*, xii., 1846, p. 102.
Astacus fossor Er., von Martens, *Monats. Akad. Wiss. Berlin*, 1868, p. 618.
Engaeus fossor Er., Haswell, *Cat. Austrl. Mus., Crust.*, 1882, p. 178; Faxon, *Proc. U.S. Nat. Mus.*, xx., 1898, p. 676; Ortmann, *Proc. Amer. Phil. Soc.*, xli., 1902, p. 292; Smith and Schuster, *Proc. Zool. Soc. Lond.*, 1913, p. 119; Faxon, *Mem. Mus. Comp. Zool.*, xl., 8, 1914, p. 403.

Length of average adult specimen 75 mm.

Rostrum short and broad, reaching to base of second segment of first antennae, apex broadly rounded; carinae blunt, continued to apex, carried well back on to carapace.

Squame of second antennae short and very broad, with a small, sharp point. Interantennal spine short, broad posteriorly, sharply pointed. Exopods of third maxillipedes indicated by a small papilla.

Sternal keel slender and sharp between great chelae and second pereopods, obsolete between second and third pereopods. First

two pairs of lateral processes small, somewhat flattened, each with a small, round opening on upper surface; processes between second pereopods large, upper margin rather sharp, a deep groove separating the pair, each with a conspicuous large, round opening; processes between third pereopods somewhat flattened, deeply grooved in centre, each with a small, oval opening along outer margin; processes between fourth pereopods long and slender.

Telson broadly cone-shaped, as long as uropods, with a spine on lateral margins; inner rami of uropods rounded, divided by a longitudinal median carina, tapering away at posterior margin; outer rami rounded, divided by a longitudinal median carina, ending in a sharp spine on the traverse suture, the suture placed at posterior third of uropods, several small spines along the suture.

Great chelae large and stout, punctate, propodus twice as long as broad, with two rows of large tubercles on upper margin, lower margin with a tuberculate carina posteriorly and a smooth carina anteriorly, a smooth carina on upper surface below cutting edge, several large tubercles along cutting edge; dactylus long and stout, punctate, upper margin with two rows of tubercles, cutting edge with one or two large, and several small, tubercles; carpus and merus each with a few scattered small tubercles on upper margin.

Posterior pleurobranch well developed.

Habitat: Magnet Mine, West Coast; Clayton Rivulet (E. Scott); Muddy Creek, Bridport; Wynyard (A. G. Powell).

Engaeus ignotus, sp. nov.

Pl. XIII, figs. 8, 8a, 8b

Length of average adult specimen 75 mm.

Rostrum slender, reaching almost to base of third segment of first antennae, apex rounded, carinae blunt, carried well back on to carapace.

Squame of second antennae short and broad, with a small, sharp spine. Interantennal spine long and slender, bluntly pointed. There is no indication of an exopod on the third maxillipedes.

Sternal keel obsolete between great chelae and second pereopods, bluntly rounded between second and third pereopods. First two pairs of lateral processes obsolete; processes between second pereopods small, bluntly rounded, each with a small, round opening; processes between third pereopods flattened, deeply grooved in centre, each with a conspicuous, irregularly rounded opening on outer margin of upper surface; processes between fourth pereopods long and slender.

Telson narrowly cone-shaped, shorter than uropods, with a spine on lateral margins; inner rami of uropods rounded, divided by a longitudinal median carina, tapering away at posterior margin;

outer rami rounded, divided by a longitudinal median carina, ending in a sharp spine on transverse suture, the transverse suture placed at the posterior third of uropod, several small sharp spines along the suture.

Great chelae short and stout, punctate; propodus one and three-fifths as long as broad, with two rows of tubercles on upper margin, lower margin with a tuberculate carina posteriorly and a smooth carina anteriorly, a smooth carina on upper surface below cutting edge, a few large tubercles along cutting edge; dactylus very short and stout, punctate and minutely tuberculate, upper margin with two feeble carina, feebly tuberculate, cutting edge with one large, and a few small, tubercles; carpus and merus each with numerous small tubercles along upper margin.

Posterior pleurobranch well developed.

Habitat: Smithton (R. H. Champion).

Types in the National Museum, Melbourne.

This species somewhat resembles *E. fossor* Er., but may be distinguished at once by the form of the rostrum, the interantennal spine, and the sternal keel.

Genus **Parastacoides** Clark

Parastacoides Clark, *Mem. Nat. Mus. Vict.*, 10, 1936, p. 48.

Carapace as high as broad, minutely tuberculate. Cervical groove deeply impressed, rounded. Rostral carinae smooth. Abdomen without spines, lateral margins rounded. First segment with lateral lobes large and rounded. Stems of podobranchs without wing-like expansions. No pleurobranchs present. Posterior arthrobranchs rudimentary. Gill formula 12 + 5r + ep.r.

Parastacoides tasmanicus (Erichson)

Pl. XIII, figs. 9, 9a, 9b

Astacus (*Astacus*) *tasmanicus* Erichson, *Arch. f. Naturg.*, xii., 1846, p. 94.

Astacus tasmanicus Er., White, *List Crust. Brit. Mus.*, 1847, p. 72; von Martens, *Monats. Akad. Wiss. Berlin*, 1868, p. 618.

Astacopsis tasmanicus Er., Haswell, *Cat. Austrl. Mus. Crust.*, 1882, p. 178; Ortmann, *Proc. Amer. Phil. Soc.*, xli., 1902, p. 292; Faxon, *Mem. Mus. Comp. Zool.*, xl., 8, 1914, p. 402 (*Incertae sedis*).

Parastacoides tasmanicus Er., Clark, *Mem. Nat. Mus. Vict.*, 10, 1936, p. 48, pl. vii., fig. 30.

The rostrum is broad, the carinae sharp, and carried well back on to the carapace; the lateral carinae are blunt. The interantennal spine is long and slender. The uropods and telson all have the posterior margin rounded.

Habitat: Lake Margaret; Mt. Lyell (R. Murray); Strahan; Queenstown.

Parastacoides inermis, sp. nov.

Pl. XIII, figs. 10, 10a, 10b

Length of largest specimen 50 mm.

Rostrum broad posteriorly, slender anteriorly, reaching to base of second segment of first antennae, apex sharply rounded; carinae sharp, carried well back on to the carapace, lateral carinae blunt.

Eyes large. Squame broad, sharply pointed, reaching beyond base of third segment of first antennae. Interantennal spine long and stout. Exopods of third maxillipedes reaching to anterior margin of ischius.

Telson broadly rounded, with a spine on each lateral margin at posterior margin. Uropods longer than telson, inner rami each divided by a longitudinal median carina produced to a long, sharp spine beyond posterior margin, posterior margin without other spines, a sharp spine half-way along outer lateral margin; outer rami each with several sharp spines along the transverse suture, upper portion of each ramus divided by two parallel longitudinal median carinae, inner carina continued across posterior portion, ending in a long, sharp spine beyond posterior margin. Telson and uropods densely, minutely tuberculate.

Sternal keel slender and sharp between second and third pereopods; first two pairs of lateral processes slender and sharp, third pair deeply grooved, slender and sharp, fourth pair deeply grooved, sharp; processes between fourth pereopods short and stout. Below lateral processes of third pereopods is a pair of large, round openings.

Great chelae stout, propodus twice as long as broad, densely tuberculate; upper margin serrated, lower margin formed by two rows of tubercles, cutting edge with one large and two or three small tubercles; dactylus stout, densely punctate, setose, cutting edge with several small tubercles, upper margin feebly tuberculate. Carpus with a row of tubercles on upper margin, and numerous small tubercles and punctures on upper surface; merus punctate, upper margin serrated.

Habitat: Adamson's Peak.

Type in the National Museum, Melbourne.

Near *P. tasmanicus* Er. in general appearance of the carapace and chelae, but readily separated by the pointed uropods.

Parastacoides insignis, sp. nov.

Pl. XIII, figs. 11, 11a, 11b

Length of adult specimens 75 mm.

Rostrum broad, reaching to base of third segment of first antennae, apex blunt; carinae sharp, carried well back on to carapace, lateral carinae obsolete.

Eyes large. Squame broad, sharply pointed, reaching to base of third segment of second antennae. Interantennal spine long and very slender. Exopods of third maxillipedes reaching to anterior margin of ischius.

Telson broadly rounded, with a spine on each lateral margin, at posterior margin. Uropods pointed, longer than telson, inner rami each divided by a longitudinal median carina, produced to a long, sharp spine beyond posterior margin, several long, sharp spines along inner half of posterior margin, a spine at apical third of outer margin; outer rami each with several sharp spines along the transverse suture, upper portion of each ramus divided by two parallel longitudinal median carinae, inner carina continued across posterior portion, ending in a long, sharp spine beyond posterior margin. Telson and uropods densely, minutely tuberculate.

Sternal keel very broad between second and third pereopods, irregularly rounded, first two pairs of lateral processes small, slender, and sharp; third pair larger, sharp; fourth pair flattened downwards, upper margins sharp. Processes between fourth pereopods short and stout. Below lateral processes of third pereopods is a pair of large, round openings.

Great chelae stout; propodus twice as long as broad, densely tuberculate, upper margin serrated, lower margin formed by two rows of tubercles, cutting edge with one large, and two or three small, tubercles; dactylus stout, densely punctate, setose, cutting edge sharp or with a few feeble tubercles, upper margin feebly tuberculate, a smooth carina on upper surface near upper margin. Carpus with a row of tubercles on upper margin, and numerous small tubercles on upper surface, upper surface punctate; merus punctate, upper margin serrated.

Habitat: Melaleuca Creek, S.W. Tasmania. Collected by Mr. C. King, and presented to the National Museum by Mr. Consett Davis.

Types in the National Museum, Melbourne.

Collected in the button-grass *(Gymnoschoenus sphaerocephalus)* swamps, between New Harbour (near the west end of the south coast of Tasmania) and the head of Melaleuca Creek, which flows into Port Davey.

Although somewhat resembling *P. inermis*, sp. nov., this species may be separated at once by the absence of the lateral carinae of the rostrum, the form of the sternal keel, and the uropods. The spines on the posterior border of the inner rami vary considerably in number in the series examined, but all have at least three very conspicuous spines.

PLATE XII

Head; *a*, interantennal spine; *b*, great chela.

FIG. 1.—*Geocharax gracilis* Clark.
FIG. 2.—*Astacopis franklinii* (Gray).
FIG. 3.—*Astacopsis gouldi* Clark.
FIG. 4.—*Astacopsis tricornis* Clark.
FIG. 5.—*Engaeus cunicularius* Erichson.

1

1a

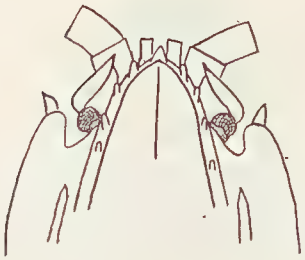
1b

2b

2a

2

3a



3

4a

3b

4b

5a

5

5b

4

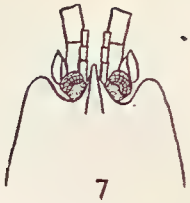
E.C.

PLATE XIII

FIG. 6.—*Engaeus leptorhynchus*, sp. nov.
FIG. 7.—*Engaeus fossor* Erichson.
FIG. 8.—*Engaeus ignotus*, sp. nov.
FIG. 9.—*Parastacoides tasmanicus* (Erichson).
FIG. 10.—*Parastacoides inermis*, sp. nov.
FIG. 11.—*Parastacoides insignis*, sp. nov.

6

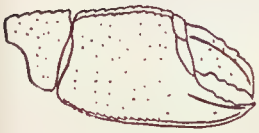
6b



7

6a

7a



8b

7b

8

11b

10b

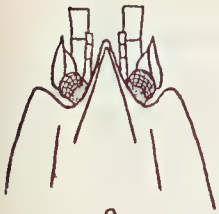
9a

8a

9b

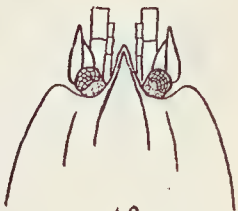
11a

10b



9

11



10

E.C.

The Description of a New Eucalypt Species

By

R. G. Brett, B.Sc.

(Read 14 November, 1938)

Plates XIV-XV

Eucalyptus Morrisbyi, sp. nov.

Arbor parva vel media 6-12 m. *alta, cortice levi deciduo, cano v. puniceo, nonnumquam aspero ad imum. Folia juvenilia bina opposita, per multis paribus, glauca, cordata v. cordato-orbicula sessilia,* 2 cm. *longa,* 2·3 cm. *lata. Folia intermedia semi-glauca elliptica vel oblongo-elliptica, alterna, petiolata,* 7·5 cm. *longa,* 3·5 cm. *lata. Folia matura lanceolata vel sub-falcato-lanceolata, alterna,* 8-10 cm. *longa,* 2·5 cm. *lata. Umbellae axillares* 3—*flora, pedunculis compressis v. sub-compressis,* 9-12 mm. *longi. Gemmae maturae glaucae, obconiculae,* 9 mm. *longae,* 7 mm. *latae, pedicellatae. Operculum plano-hemisphaericum, apiculatum, brevius tubo calycino. Fructus glaucus, sub-cylindricus v. sub-urceolatus, sub-costatus,* 8 mm. *longus,* 8·5 mm. *latus. Valvae inclusae.*

A small to medium glaucous tree, with pruinose branchlets, 6-12 m. high. Bark grey to pink, smooth deciduous, sometimes rough at the base. Juvenile leaves opposite for an indefinite number of pairs, glaucous, cordate, crenulate, sessile, and slightly amplexicaul, 2 x 2·5 cm., or larger. Intermediate leaves sub-glaucous, elliptical to oblong-elliptical, 7·5 x 3·5 cm., or larger. Some trees, although mature, do not pass out of intermediate foliage. As in the case of *E. subcrenulata* Maiden and Blakely, this is probably determined by edaphic conditions. Thus the reduced alpine forms of *E. subcrenulata* rarely develop adult foliage. Mature leaves alternate, lanceolate to sub-falcate lanceolate, undulate, sub-glaucous, petiolate, 8-10 cm. x 2·5 cm., petioles 2·5 cm., or longer. Umbels axillary, three-flowered. Peduncles compressed to sub-terete, 9-12 mm. Mature buds obconical, glaucous, pedicellate, the central pedicel developed more than the

laterals, 9 x 7 mm. Operculum apiculate to subumbonate, depressed hemispherical, shorter than the sub-costate calyx tube. Fruit pedicellate, depressed cylindrical to sub-urceolate, glaucous, sub-costate, 9 x 8·5 mm. Valves enclosed, tips sometimes slightly protruding.

Habitat: Confined to coastal levels, and thrives on poor, sandy soil.

Distribution: As far as can be judged at present this species is almost extinct. It is confined to a thin belt of trees skirting the beach at the junction of the South Arm and Clifton Beach roads, S.E. Tasmania. An avenue of *E. Morrisbyi,* containing an interesting hybrid with *E. viminalis,* was planted about 50 years ago by Mr. J. R. Morrisby on 'Waterloo', the property of Mr. A. Morrisby. Messrs. A. and M. Morrisby assert that the species formed a dense scrub of at least 50 acres in extent before clearing was undertaken. The rareness of the species resembles that of *E. cordata* Labill.

Genetic Character: E. Morrisbyi is a simple species constituting a single biotype. (Brett, 1938, p. 77.)

Affinities: With *E. cordata* Labill., *E. divaricata* McAulay and Brett, and *E. urnigera* Hook., f.

Hybrids: With *E. viminalis* Labill. The trees retain the general appearance of *E. viminalis,* but fruit and buds are sub-glaucous to glaucous, with valves partially sunk. The buds resemble those of *E. viminalis,* but are somewhat diamond shaped.

Economic Value: The principal economic value of this species is its power to flourish on sandy, coastal soils, where it forms an excellent windbreak. For this purpose it should be planted extensively in Tasmania and on the mainland.

The timber, although not highly recommended for fencing, is reported to make excellent fuel, and should be planted on properties at sea level where timber for firewood is scarce.

The graceful habit and glaucous character suggest suitability for ornamental culture.

References

Brett, R. G., 1938.—A Survey of Eucalyptus species in Tasmania. *Pap. Roy. Soc. Tasm.,* 1937 (1938), pp. 75-109.

PLATE XIV

A.—Intermediate leaves. B.—Adult leaf.

B
A
A
A
R.K.

PLATE XV

FIG. 1.—Sucker foliage showing quadrangular stems.

FIG. 2.—Juvenile foliage of twelve months old seedling, raised from seed collected from tree selected as type.

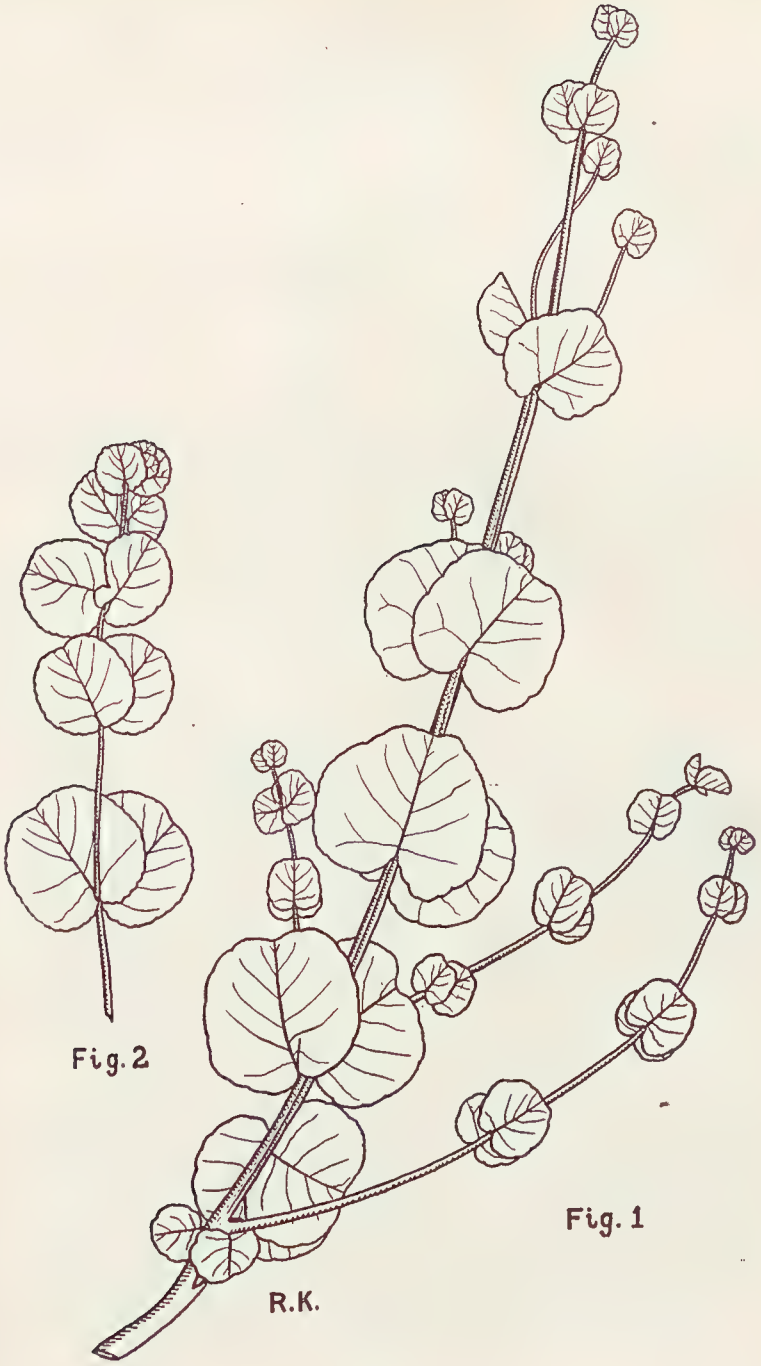


Fig. 2
Fig. 1
R.K.

Production of Saltants of *Chaetomium globosum* by Monochromatic Ultra-Violet Irradiation

By

A. L. McAulay

(Read 14 November, 1938)

Plate XVI

Experiments have been made on the production of mutations by irradiation with monochromatic ultra violet light. The basic object of the experiments was to see whether thresholds exist in this phenomenon of the type familiar in photo-chemical reactions. If such thresholds can be demonstrated, a technique of analysis of biological material might be opened up similar to that used by the physicist in his investigation of atomic nuclei, atoms, and molecules.

Three classes of biological material have been tentatively tried: (i) maize pollen, (ii) *Drosophila* larvae, (iii) spores of the fungus *Chaetomium globosum*—

(i) The work on maize has been given up, as the results have been less encouraging than (ii) and (iii).

(ii) Results of interest have been obtained with *Drosophila* by M. C. Taylor, working in this laboratory. The work is technically difficult, and progress must necessarily be slow.

(iii) A preliminary set of experiments has been completed, in which the spores of *Chaetomium globosum* have been irradiated, and results encouraging from the viewpoint of the main problem have been obtained.

A stage has now been reached where it appears that the most profitable course is to start afresh, using improved methods suggested by the preliminary experiments. The purpose of the present note is to record a few results of interest that have been obtained during the past year. *Chaetomium* was chosen for investigation because of the work of Dickson (1932, 1933) on irradiation by X-rays and heterogeneous ultra violet light of *C. cochliodes* and other species. *C. globosum*, according to Dickson's results, is the least suitable species, but was used as I was able to obtain it in Australia owing to the kindness of Dr. Waterhouse of the Agricultural Department, University of Sydney, who presented me with a culture.

Apparatus and Methods

A monochromator was constructed in this laboratory, of the general type described by Bowden and Snow (1934), using fused quartz lenses and prisms supplied by Messrs. Sharland, of Thavies Inn, London. The diameter of the lenses is 10 cm., their focal length of the order of 15 cm., and the side of the prisms 8 cm. Most of the work has been done using a mercury vapour arc lamp, but condensed sparks have also been used. Intensities have been measured with a Hilger thermopile.

Spores were spread on uranium glass and irradiated in the focussed spectrum. Intensities available by this method are high, and doses up to 3000 joules per sq. cm. have been given with the 365 $m\mu$ mercury line. The irradiated spores were picked up on a brush and transferred to malt agar in a petri dish. The number of spores in a colony separated in this way was very variable, but was to some extent under control. In the experiments to be described it averaged about 50.

Using the above methods, contamination of the spectral line by scattered radiation was serious, and for this reason the early experiments are not here considered. Later, filters were used with the monochromator, and the results should be trustworthy up to a point, though contamination of 313 $m\mu$ by 302 $m\mu$ and of 334 $m\mu$ by 313 $m\mu$ may still have taken place.

Scope of Experiments and General Results

Experiments were made with wave-lengths 365 $m\mu$, 334 $m\mu$, 313 $m\mu$, 280 $m\mu$, 265 $m\mu$, 254 $m\mu$, and 230 $m\mu$, but most of the irradiation was given with 254 $m\mu$, 313 $m\mu$, 334 $m\mu$, and 365 $m\mu$. Table I indicates the scope of the experiments. Only those saltants have been included which were successfully separated in an apparently pure state, and remained constant in character for at least five or six sub-cultures.

TABLE I

	Wave-length. mμ	No. of Colonies Surviving.	No. of Saltants Separated.	Saltants % of Colonies. %	Average Dose Joules/cm.²
A	254	224	16	7	1·7
	313	163	13	8	143
	334	176	4	2	26·8
	365	239	3	1	515
B	365	180	1	½	2800
Control		396	1	¼	—

It will be noticed in Table IA that the number of saltants produced by 334 $m\mu$ and by 365 $m\mu$ is very much smaller than by 254 $m\mu$ and 313 $m\mu$. The reason for this is quite different in the two cases. Owing to difficulties in irradiating with 334 $m\mu$, the average dose given was much below the optimum, and the corresponding production of saltants was low. This was not the case with 365 mu, and it was suspected that the three saltants that appeared might be due to contamination by scattered radiation, owing to the very long exposures necessary. B shows the result of an experiment made under more stringent conditions to check this point. The irradiation was here carried to a point where about two-thirds of the spores were killed, and the fact that only one saltant appeared from 180 colonies suggests that 365 $m\mu$ kills before it produces saltants. Continuous irradiation for more than a week was necessary.

The one saltant that appeared in control came at the end of the series of experiments, and contributed to the decision to terminate them and start afresh with new material.

Energy Required to Produce Saltants at Different Wave-Lengths

Saltants are produced over a large range of dosage, and there appears to be an optimum value for the number of saltants produced per colony surviving. Doses very near the lethal probably are less effective under the conditions of these experiments than something less than this. An estimate of this optimum from the present experiments may easily be in error by a factor of 2, but, owing to the very large variations of sensitivity at different wave-lengths, it is still of considerable interest.

Table II shows the orders of magnitude of the doses required to produce saltants.

TABLE II

Wave-length. $m\mu$	*Order of Magnitude of Optimum Dose Joules/cm.*^{2}
230	2
254	2
265	2
313	200
334	200
365	2000

Certain points of interest are apparent. All the doses are very large compared with those required to produce other biological effects, which have been measured in this laboratory. They are, for example, at corresponding wave-lengths over 100 times as great as M. C. Taylor has found to be lethal to *Drosophila* larvae, and I have found to be lethal to *Bacillus coli*.

The effectiveness of wave-lengths between 230 $m\mu$ and 265 $m\mu$ is of the same order of magnitude, but at 313 $m\mu$ about 100 times the dose is needed for the same effect. There is no evidence that 334 $m\mu$ is less effective than 313 $n\,\mu$, but at 365 $m\mu$ very few or no saltants are produced, even with doses ten times as great. It should be noticed that if the insensitivity of this material to irradiation is due to anything in the nature of an impenetrable coat the great difference between the short and long doses would be still greater. There is suggestion of discontinuous increases in efficiency in producing saltants as the wave-length is decreased.

Rough measurements indicate that practically all the radiation falling on a spore is absorbed by it, even at wave-lengths as long as 365 $m\mu$. This leads to the conclusion that at 313 $m\mu$ a region of the order of volume of an atom (say, 3×10^{-23} ccs.) absorbs on an average 20 quanta during the delivery of the optimum dose. Even allowing for four saltants out of five to be missed in the subsequent separation, this absorption produces less than one saltant for 100 spores irradiated. The consequences of this inefficiency are suggestive. If it is due to strong absorption in a sheath external to the sensitive region responsible for the production of a saltant, as pointed out above, the difference between the effectiveness of short and long waves must be even greater than the hundred to one given directly by experiment. If there is no protecting sheath, many quantum hits must be made within every atom of the sensitive region before one is effective in producing a saltant.

THE SELECTIVE PRODUCTION OF SALTANTS

In an attack on the main problem, the first effect to be looked for is a selective production of saltants. One might expect greater homogeneity among the saltants produced by long wave-lengths than among those produced by short. The results obtained show that the

phenomenon is very complicated, and it is not claimed that a decisive result has been achieved, but the evidence suggests rather strongly that saltants are produced selectively at different frequencies.

The saltant St. II (fig. 1) is very different from the parent. The following may be taken as criteria by which it may be specified. It is sterile under the standard experimental conditions employed. The aerial mycelium is very sparse. The substratum is dark brown, and dark-red hyphae can easily be seen veining the medium, while the parent hyphae cannot be seen in the medium. The growth of the saltant is slower than that of the parent. It forms a dense leathery skin on the surface of the medium with a tendency to wrinkle.

Plate XVI, fig. 1, shows two photographs of the saltant, eight days old, taken by reflected and transmitted light, and comparison photographs of the normal fungus, eight days old, and of *C. murorum*, 13 days old. In many respects St. II resembles *C. murorum* more closely than its parent. *C. murorum* is sterile in the standard experimental conditions.

Table III records the appearance of St. II among the experiments under consideration, also the diversity of types at three different wave-lengths.

TABLE III

Wave-length.	*Total Number of Saltants.*	*Number of Definitely Distinct Types.*	*Number of Occurrences of St. II.*
254	18	13	1
313	13	7	4
334	4	2	3

In view of the small numbers involved, perhaps the fairest way to present the results is to regard the irradiations as grouped into two classes, 'long' 334 $m\mu$ and 313 $m\mu$, and 'short', 254 $m\mu$. St. II appears seven times out of 17 among the long, and once only, and this a doubtful one, out of 18 among the short wave-lengths. The indications are not, of course, that St. II is produced more freely by the long wave-lengths (the doses given are 100 times as great in this region), but that a larger variety of saltants are produced by the short wave-lengths. This is borne out to some extent by the fact that 13 out of 18 of the short-wave saltants are distinct from one another, while only eight out of 17 of the long-wave saltants are of different types.

GENERAL NATURE OF SALTANTS

The following are some of the principal characters that have been observed in the saltants produced in this work.

Saltants are produced with very dense aerial mycelium. In one class this lies close to the medium, giving a matte appearance like filter-paper. In another it is deep as well as dense, completely hiding everything beneath it. The paper-like mycelium may be white or pink, the deep mycelium white or yellow. Both paper-like and

deep mycelium may be sterile or carry fertile perithecia. In some saltants the perithecia form on top of the dense, deep aerial mycelium, in some what look like small sterile perithecia without hairs form beneath the surface of the medium. Two saltants form sclerotia. Another shows marked zones, the zoning character appearing in all the progeny, whether grown from mycelium or spores. Perithecia may be yellow-white, blue turning black, or black. All these are fertile, and the spores breed true. There are varying types of infertile perithecia, ranging from bodies looking very like the fertile parent perithecia to small, round translucent bags without hairs. The growth rate varies in different saltants, and may be the same, greater, or less than that of the parent. Plate XVI, fig. 2, shows photographs of a few selected saltants.

Irradiation of Saltants and Reproduction of the Parent from a Saltant

Spores from two of the saltants have been irradiated. Though these saltants were apparently quite stable normally, they both saltated freely when irradiated. This work has not yet been followed up, and only one or two of the secondary saltants have been separated in an apparently pure state. One was apparently identical with the parent (Plate XVI, fig. 3), and has remained so through several sub-cultures. This is in agreement with a similar result observed by Dickson (1932) with *C. cochliodes*, using X-rays. It is, of course, of particular interest as showing that the action of the radiation cannot be looked on as merely destructive. The reproduction of the parent form from the saltant was, in this case, brought about by a wave-length of 230 $m\mu$.

Summary

The following are the most important new facts recorded:—

(i) The optimum dose of ultra violet radiation for the production of saltants in *C. globosum* is of the following order—

Short wave-lengths, 230 $m\mu$ to 265 $m\mu$, 2 x 10^7 ergs/cm^2.

313 $m\mu$, and probably 334 $m\mu$, 200 x 10^7 ergs/cm.^{2}

365 $m\mu$, if effective at all, 2000 x 10^7 ergs/cm.^{2}

(ii) The effectiveness of ultra violet radiation in producing saltants in *C. globosum* is very small (or perhaps zero) at wave-lengths as long as 365 $m\mu$. The ratio saltant-producing effect to lethal effect is smaller than for shorter wave-lengths.

(iii) A saltant produced by irradiation, which was quite stable under normal conditions, saltated freely on irradiation and, among other things, reproduced the parent strain.

In addition to the above facts, it is shown that there is evidence that suggests that saltants are produced selectively by different wavelengths. This is an aspect of the primary object of the investigation, and a fresh series of experiments is planned to follow it up.

The funds required for the above work came from the Commonwealth Research Grant to the University. I wish to thank the trustees of the Science and Industry Endowment Fund for a grant for apparatus made me in 1936, and Dr. W. L. Waterhouse, of the Department of Agriculture, University of Sydney, who very kindly supplied the culture of *Chaetomium globosum*, which has provided the material for these experiments.

References

DICKSON, H., 1932.—The Effects of X-rays, Ultra Violet Light and Heat in producing Saltants in *C. cochliodes* and other Fungi. *Annals Bot.* 46. pp. 389-405.

DICKSON, H., 1933.—Saltations induced by X-rays in Seven Species of *Chaetomium*. *Annals Bot.* 47. pp. 735-754.

BOWDEN AND SNOW, 1934.—Physico-chemical Studies of Complex Organic *Molecules*. Part I.: Monochromatic Irradiation. P.R.S. (B) 115. pp. 262-273.

PLATE XVI

FIG. 1:

a. Four colonies of normal *C. globosum*, 8 days old, reflected and transmitted light. × ⅓.

b. Four colonies of St. II. Four separate saltants produced by 313 *mμ*, 8 days old, reflected and transmitted light. × ⅓.

c. Four colonies of *C. murorum*, 13 days old. × ⅓.

FIG. 2.—Typical saltants produced by irradiation:

a. Produced by 254 *mμ*, 8 days old. Bottom, zoning fungus, produces sparse fertile perithecia after about a month. × ⅓.

b. Four saltants produced by 313 *mμ*, 8 days old. Bottom, fungus bears black perithecia on top of dense, deep, dirty-white mycelium. × ⅓.

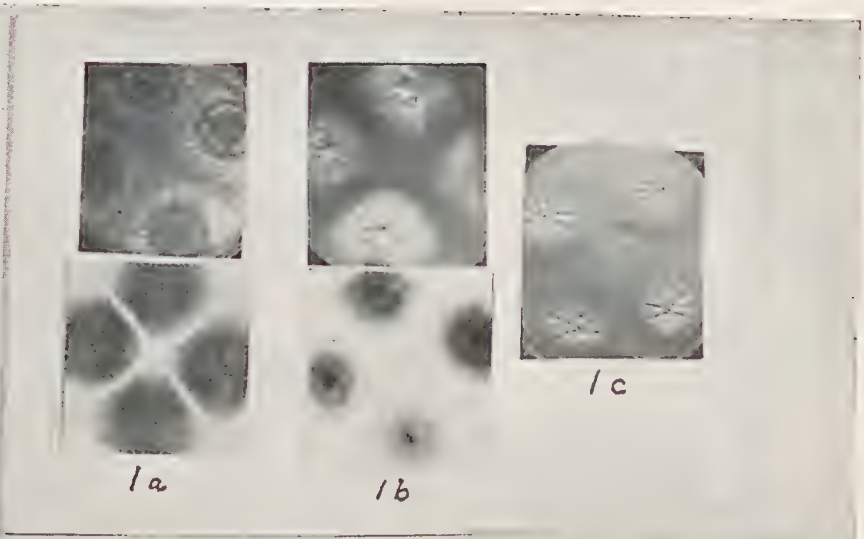
c. Saltant, produced by 254 *mμ*, showing knots of sclerotia. It periodically produces dense, white, barren mycelium (see top right). These characters are reproduced in sub-cultures. × ⅓.

d. Two slow-growing saltants produced by 254 *mμ*, 17 days old. Both bear barren perithecia. The branching fern-like mycelium of the top one can be seen under the surface of the medium × ⅓.

e. Very slow growing dense saltant which wrinkles surface of medium, 8 days old. Compare 1*a* normal fungus of same age. × ⅓.

f. Photograph of perithecia on an older culture of e. The saltant comes true from spore or mycelium subcultures. Natural size.

FIG. 3.—The saltant which on irradiation reverted to the parent form. The reversion is in the middle, flanked on either side by colonies of the saltant from which it arose. Natural size.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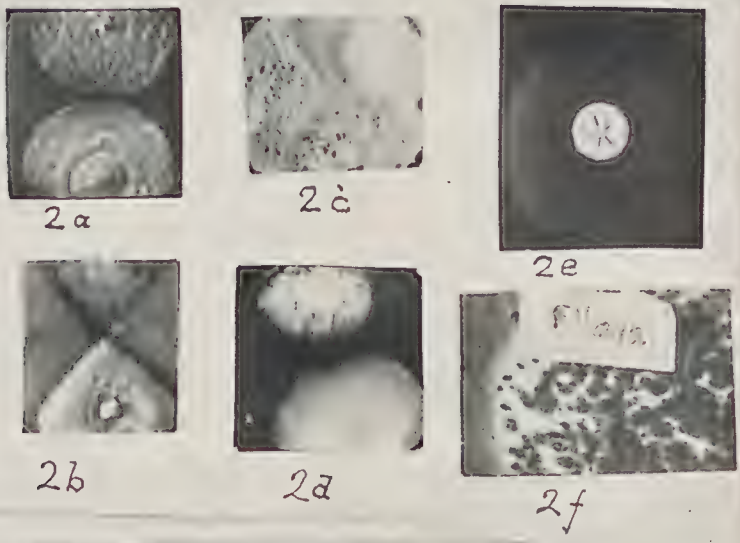
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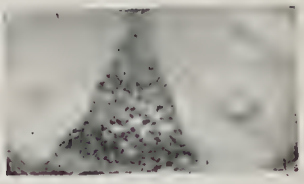
3

Observations on Some Tasmanian Fishes.

Part IV

By

E. O. G. Scott, B.Sc.

(Read 14th November, 1938)

The present paper, the precise scope of which is summarized in the concluding paragraph, follows the general plan of previous communications under the same title (1934, 1935b, 1936).

Keys are provided for the families containing the Tasmanian species dealt with in the present paper. It is hoped that these keys may also help in the identification of species hitherto not recorded from Tasmania.

Registration numbers are those of the Queen Victoria Museum, Launceston.

Family SYNGNATHIDAE

In the Australian Check-List (McCulloch, 1929) only seven members of the family, representing six genera, are accredited to Tasmania, namely: (*a*) *Leptonotus semistriatus* Kaup, 1856; (*b*) *Histiogamphelus briggsii* McCulloch, 1914; (*c*) *Stigmatopora argus* (Richardson, 1840); (*d*) *S.nigra* Kaup, 1856; (*e*) *Solegnathus spinosissimus* (Günther, 1870); (*f*) *Phyllopteryx foliatus* (Shaw, 1804); (*g*) *Hippocampus (Macleayina) abdominalis* Lesson, 1827: in the case of (*b*), (*c*), (*d*) Tasmania affords the type-locality. To these may be added the following species: (*h*) *Corythoichthys phillipi* (Lucas, 1891); (*i*) *Urocampus carinirostris* Castelnau, 1872; (*j*) *Leptoichthys fistularius* Kaup, 1853; (*k*) *Solegnathus fasciatus* (Günther, 1880); (*l*) *S.robustus* McCulloch, 1911; (*m*) *Hippocampus breviceps* Peters: of these (*h*), (*j*), (*k*), (*l*), (*m*) are discussed in the present series of papers; (*i*) is recorded by Lord and Scott (1924).

A key to the Tasmanian Syngnathidae, and to most of the species recorded from Victoria and South Australia, [1] is appended.

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[1] Species recorded from Victoria not incorporated in key are *Hippocampus tristis* Castelnau, 1872, *H.bleekeri* Fowler, 1908, *H.agnesae* Fowler, 1908; from South Australia, *Syngnathus pelagicus* Linné, 1758.

Key to Syngnathidae Recorded from Tasmania: With some Diagnostic Characters [in Square Brackets] of Allied Species Occurring in Victoria and South Australia.

1. Caudal fin present (sometimes rudimentary). Tail not prehensile .... (2)
   Caudal fin absent. Tail often prehensile ... . (14)

2. Body smooth, without ridges, the angles scarcely defined. Dorsal fin short, borne on 3 annuli; its base = its height. Tail > 4.0 trunk
   [D. 11. Annuli 12 + 60; subdorsal 1 + 2. Snout 3.1 in head. Eye 2.0 in snout. Head 2.5 in trunk. Trunk 4.8 in tail. Length 100mm. .... *Lissocampus caudalis*]
   Body with longitudinal ridges, the angles well-defined. Dorsal fin long, or moderately long, borne on more than 4 annuli; its base > its height. Tail < 4.0 trunk .... (3)

3. Dorsal edges of trunk and tail not continuous .... (4)
   Dorsal edges of trunk and tail continuous
   [D. 26-27. Annuli 19-20 + 40-41; subdorsal 1-2 + 5. Snout with elevated obtuse crest; 4.7 in head. Eye 1.3 in snout. Head 3.6-4.4 in trunk. Length 215mm. .... *Ichthyocampus cristatus*]

4. Dorsal fin far (> length of its base) behind vent
   D. 14. Annuli 8-9 + 43-53; subdorsal 7-10 of caudal. Snout 3.0-3.3 in head. Eye 1.3 in snout. Head 1.5-2.5 in trunk. Length 110mm. .... *Urocampus carinirostris*
   Dorsal fin over, or near (< length of its base from), vent .... (5)

5. Caudal annuli > 30. Length of caudal fin < distance from anterior border of eye to opercular margin .... (6)
   Caudal annuli < 30. Length of caudal fin > (about 2) distance from anterior border of eye to opercular margin
   D. 34-38. Annuli 25-28 + 20-27; subdorsal 3-4 + 5-6. Snout 1.4 in head. Eye 7.1 in snout. Head 2.0-2.5 in trunk. Length 360mm. .. .. *Leptoichthys fistularius*

6. Dorsal crest on snout a conspicuous knife-like ridge, at least ½ as high as tubular portion of snout. Base of dorsal fin elevated above general dorsal profile. Tasmanian species with vent posterior to middle of dorsal fin .... (7)
   Dorsal crest on snout small, < ½ as high as tubular portion of snout. Base of dorsal fin not elevated above general dorsal profile. Tasmanian species with vent anterior to middle of dorsal fin .... (8)

7. Vent posterior to middle of dorsal fin. Total annuli < 63. Dorsal fin with 28 rays. Snout subequal to rest of head
   D. 23. Annuli 22 + 36; subdorsal 5 + 2. Snout 2.1 in head. Eye 2.5 in snout. Head 4.6 in trunk. Length 235mm. *Histiogamphelus briggsii*
   Vent anterior to middle of dorsal fin. Total annuli > 63. Dorsal fin with > 28 rays. Snout about 2 rest of head
   [D. 32-33. Annuli 25-26 + 44; subdorsal 3 + 7. Snout 1.5 in head. Eye 7.4 in snout. Head 1.9 in trunk. Length 280mm. .... *Histiogamphelus rostratus*]

8. Female with dorsal surface conspicuously elevated, ventral surface acute. Tasmanian species with > 30 dorsal rays.... .... (9)
   Female more or less like male. Tasmanian species with < 30 dorsal rays . . . . (11)

9. No ridge on opercle. Dorsal fin with >35 rays. Snout > ½ head
D. 38-40. Annuli 20-21 + 47-49; subdorsal 4-5 + 6-7. Snout 1.6-1.7 in head. Eye 7.2 in snout. Head 1.9 in trunk. Length 235mm. . . . . *Leptonotus semistriatus*

Ridge on basal half of opercle. Dorsal fin with < 35 rays. Snout < ½ head .... (10)

10. Vent anterior to middle of dorsal fin. Trunk ½ total length. Subdorsal annuli < 7
[D. 24. Annuli 17 + 42-44; subdorsal 1 + 5. Snout 2.3 in head. Head 4.0-4.5 in trunk. Length 100mm. .... *Leptonotus caretta*]

Vent posterior to middle of dorsal fin. Trunk < ¾ total length. Subdorsal annuli > 7
[D. 28-32. Annuli 16-17 + 37-38; subdorsal 5-6 + 3-4. Snout 2.6 in head. Eye 2.5 in snout. Head 2.5 in trunk. Length 120mm. .... *Leptonotus costatus*]

11. Opercle with raised radiating lines, but no median keel. Head > 2.75 in trunk
[D. 20-24. Annuli 18-19 + 42-44; subdorsal 0-1 + 4-5. Snout high. Ventral surface wider than dorsal surface. Snout 2.5-2.7 in head. Eye 1.8 in snout. Head 3.0-3.5 in trunk. Length 160mm. .... *Syngnathus curtirostris*]

Opercle with prominent median keel. Head < 2.75 in trunk .... (12)

12. Snout > 2.3 in head; the latter > 2.3 in trunk. Eye larger; < 6.5 in head, < 3.0 in snout. Upper body ridge continued on to 4th caudal scute
[D. 18-20. Annuli 16-17 + 41-43; subdorsal 0-1 + 4-5. Snout 2.5 in head. Eye 2.5 in snout. Head 2.5 in trunk. Ventral surface of trunk V-shaped and ridged. Length 100mm. *Corythroichthys vercoi*]

Snout < 2.3 in head; the latter < 2.3 in trunk. Eye smaller; > 6.5 in head, > 3.0 in snout. Upper body ridge continued beyond 4th caudal scute .... (13)

13. Head > 1.7 in trunk. Eye < 4.0 in snout. Upper body-ridge continued on to 5th caudal scute
D. 22-28. Annuli 18-20 + 40-48; subdorsal 1-2 + 5-6. Snout 1.9 in head. Eye 3.4 in snout. Head 2.0 in trunk. Length 130mm. .... *Corythroichthys phillipi*

Head < 1.7 in trunk. Eye > 4.0 in snout. Upper body-ridge continued on to 6th caudal scute
[D. 26-29. Annuli 19-20 + 44-49; subdorsal 1-2 + 5-6. Snout 1.75 in head. Eye 4.5 in snout. Head 1.4 in trunk. Length 270mm. .... *Corythroichthys poecilolaemus*]

14. Head, trunk and tail with conspicuous foliaceous appendages. Tail prehensile .... (15)

Without such conspicuous foliaceous appendages. Tail prehensile or not prehensile .... (16)

15. Foliaceous appendages simple. Ventral segmental spines short (one eye-diameter, or less). Snout > 3 postorbital portion of head. Subdorsal annuli > 10
D. 27-36. Annuli 17-18 + 32-37; subdorsal 1-2 + 5-7. Snout 1.4 in head. Eye 7.1 in snout. Head 1.3-1.5 in trunk. Length 390mm .... *Phyllopteryx foliatus*

Foliaceous appendages multifid. Ventral segmental spines long (up to two eye-diameters, or more). Snout < 3 postorbital portion of head. Subdorsal annuli < 10
[D. 35-37. Annuli 18-19 + 36-40; subdorsal 0-1 + 11. Snout 1.6-1.7 in head. Eye 4.8-5.1 in snout. Head 1.3 in trunk. Length 300mm. .... *Phyllopteryx aequs*]

16.
- Trunk broader than deep. Length from eye to origin of dorsal fin < base of dorsal fin. Body-annuli > 15, < 23. Subdorsal annuli > 14. Tail not prehensile ... (17)
- Trunk deeper than broad. Length from eye to origin of dorsal fin > base of dorsal fin. Body-annuli < 15, or > 23. Subdorsal annuli < 14. Tail prehensile ... (18)

17.
- Vent posterior to middle of dorsal fin. Mediolateral body-ridge extending on to 1st caudal scute (in the greatly expanded female produced to form a sharp edge). Well-developed opercular keel
  D. 35-43. Annuli 16-18 + 58-72; subdorsal 10-12 + 6-7. Snout 1.6-1.7 in head. Eye 5.0-6.3 in snout. Head 1.6 in trunk. Length 110mm. ... *Stigmatopora nigra*
- Vent below, or anterior to, middle of dorsal fin. Mediolateral body-ridge extending on to about 6th caudal scute, or beyond, or terminating in skinny folds of brood-pouch. No opercular keel in adult
  D. 43-55. Annuli 17-22 + 68-90; subdorsal 7-10 + 8-12. Snout 1.5 in head. Eye 6.2-7.6 in snout. Head 1.3 in trunk. Length 250mm. ... *Stigmatopora argus*

18.
- Head not noticeably equine, its depth < (about $\frac{1}{2}$) length of snout. Body-annuli > 15. Total annuli > 65 ... (19)
- Head decidedly equine, its depth > length of snout. Body-annuli < 15. Total annuli < 65 ... (21)

19.
- Trunk about 2.0 head. Depth of snout 6, or more, in its length. Depth of tail immediately behind the dorsal fin, 4, or more, in base of dorsal. Mediolateral ridge attains, or virtually attains, dorsal profile immediately behind termination of dorsal fin ... (20)
- Trunk about 2.5 head. Depth of snout 5 in its length. Depth of tail immediately behind the dorsal fin about 3 in base of dorsal. Mediolateral ridge attains dorsal profile near, or behind, middle of tail
  D. 29-34. Annuli 26-27 + 48-53; subdorsal 0 + 10. Eye 3.9 in snout. Snout 1.7-1.9 in head. Head 2.4-2.7 in trunk. Each trunk-scute with flattened central spine, from which radiate lines of smaller, but well-developed, spines. Length 365mm. ... *Solegnathus robustus*

20.
- Scutes intensely spiny. At middle of either lateral border of each trunk-scute a four- or five-rayed cluster of spines, diverging from an enlarged central spine or small group of spines
  D. 35-38. Annuli 27-29 + 51-55; subdorsal 0 + 10. Eye 4.0-5.0 in snout. Snout 1.7 in head. Head 2.0 in trunk. Each trunk-scute with a system of spinigerous ridges in the form of a lozenge, or ellipse, and a vertical ridge running from apex to apex; vertical ridge terminating in a large two- or three-crowned spine forming part of longitudinal body-ridge. Length 320mm. ... *Solegnathus spinosissimus*
- Scutes mainly rugose. At middle of either lateral border of each trunk-scute a spinigerous fusiform fascia, with an enlarged central spine, or an elliptical boss with elevated centre from which radiate numerous rows of blunt spinules
  D. 39-41. Annuli 25-28 + 53-55; subdorsal 0 + 10-12. Eye 4.0-5.0 in snout. Snout 1.7 in head. Head 2.0 in trunk. Each trunk-scute with a system of from about three to six subvertical rather sparsely, often obscurely, spinigerous ridges that through most of their length are subparallel, generally becoming approximated above and below, where they terminate in a large two- or three-crowned spine forming part of longitudinal body-ridge. Length 370mm. ... *Solegnathus fasciatus*

21. Axis of head virtually in line with that of trunk, the angle included between ventral cephalic and thoracic profiles much > 90°. Dorsal and ventral profiles of trunk subparallel. Tail without prominent tubercles. Occiput compressed into a crest, without coronet
[D. 15. Annuli 12 + 38; subdorsal 3 + 1. Eye 1.5-1.8 in snout. Snout 2.9-3.2 in head. Head 2.0 in trunk. Length 55mm. .... *Acentronura australis*]

Axis of head markedly oblique to that of trunk, the angle included between ventral cephalic and thoracic profiles (usually much) < 90°. Dorsal and ventral profiles of trunk convex in opposite senses. Tail with prominent tubercles. Occiput compressed into a crest, produced behind to form coronet .... (22)

22. Dorsal rays > 24. Dorsal base on 6, or more, annuli, of which 3, or more, are caudal. Total annuli > 54
D. 26-31. Annuli 11-13 + 44-49; subdorsal 3-5 + 3-5. Eye 2.5 in snout. Snout 2.5 in head. Head 1.7 in trunk. Length 260mm. .... *Hippocampus abdominalis*

Dorsal rays < 24. Dorsal base on fewer than 6 annuli, of which fewer than 3 are caudal. Total annuli < 54 .... (23)

23. Dorsal rays > 18. Snout > 2.5 in head. Eye < 3 in snout. Minimum nuchal depth < half maximum depth of trunk. Total annuli > 48
D. 19-22. Annuli 11 + 38-42; subdorsal 3-4 + 1. Eye 2.1 in snout. Snout 3.0 in head. Head 1.5 in trunk. Length 70mm. .... *Hippocampus breviceps*

Dorsal rays < 18. Snout < 2.5 in head. Eye > 3 in snout. Minimum nuchal depth > half maximum depth of trunk. Total annuli < 48
[D. 16-17. Annuli 11 + 33-36; subdorsal 2-3 + 1. Eye 3.5 in snout. Snout 2.0 in head. Head 1.2 in trunk. Length 160mm. .... *Hippocampus novae-hollandiae*]

Genus **Corythoichthys** Kaup, 1853

Corythoichthys phillipi (Lucas, 1891)

Syngnathus phillipi Lucas, *Proc. Roy. Soc. Vict.* (n.s.) III. 1891. pp. 8 and 12.

Distribution.—To distribution in Check-List (Victoria, South Australia) may be added Western Australia (Waite and Hale, 1921), Tasmania (McCulloch, 1911).

Genus **Leptoichthys** Kaup, 1853

Leptoichthys fistularius Kaup, 1853

Leptoichthys fistularius Kaup, *Arch. Naturg.* XIX. 1. 1853. p. 233: *ex Typhus fistularius* Bibron MS.

Record.—Specimen (Reg. No. 916FR) picked up on beach at Bridport by Miss Betty von Steiglitz, January, 1936. First record for Tasmania.

Remarks.—Although somewhat abraded, and having the greater part of the snout and the tip of the caudal fin missing, the specimen is clearly referable to this species. In its present condition the fish has a total length of 270 mm., to which perhaps 50 mm. would have been added when it was perfect. Annuli 25 + 20, of which 3 + 6 are subdorsal.

Distribution.—To distribution in Check-List (Western Australia, South Australia) may be added Victoria (Waite and Hale, 1921; Mack, 1934), Tasmania.

Genus **Leptonotus** Kaup, 1853

Leptonotus semistriatus Kaup, 1856

(Text fig. 1)

Leptonotus semistriatus Kaup, *Arch. Naturges.* XIX. 1. 1853. p. 233: *nom. nud.*
Id. Kaup, *Cat. Lophob. Fish. Brit. Mus.* 1856. p. 48.

Syngnathus semifasciatus Günther, *Cat. Fish. Brit. Mus.* VIII. 1870. p. 162: *emend. pro Leptonotus semistriatus* Kaup.

Syngnathus verreauxianus Duméril, *Hist. Nat. Poiss.* II. 1870 p. 573.

Distribution.—To distribution in Check-List (South Australia, Tasmania) may be added Victoria (Mack, 1934). Waite and Hale (1921) exclude this species from the South Australian list, interpreting ' South Australia '—which Günther (1870) stated was written on label of holotype, though Kaup (1856) had stated its origin was not noted—as ' Southern Australia,' and stating they have no records of it from South Australia, where, they believe, its place is taken by *L. costatus* Waite and Hale.

Remarks.—Australian literature available here does not include any recent descriptive account of this species, and no illustration appears to have been published: a redescription and figure, based on a Victorian specimen, are offered below.

Description.—D.38. P.11. C.5. A.5. Annuli 20 + 47; subdorsal annuli 4 + 7.

Head 2.8 in length to vent, 6.4 in length to base of caudal, 6.5 in total length. Eye 6.0 in snout, which is 1.6 in head. Base of dorsal 3.7 in length to its origin. Maximum depth 18.0, depth at opercular margin 33.2, at origin of dorsal 22.7, at vent 32.2, at middle of tail 72.0, in total length.

Smooth, without spines. Head and body compressed, maximum width of latter 2.4 in maximum depth. Tail subquadrangular, its width at vent 1.3 in its depth there, its width at middle 1.1 in its depth there. Seven trunk-ridges, including median ventral keel; all rather small, but well defined: dorsal surface of trunk unridged, gently arched. Superolateral trunk ridge continued to near middle of sixth caudal scute; mediolateral ending in hinder third of last body-scute; posterolateral continuous with that of tail; ventral ending just in advance of vent: superolateral ridge of tail originating near anterior margin of last body-scute, attaining dorsal profile about 11 annuli in advance of origin of caudal.

Snout long and slender, rather more than twice postorbital portion of head; nostril about two-thirds an eye-diameter in advance of orbit. Interorbital space nearly flat, bounded by feeble supraorbital ridges,

which converge anteriorly and meet at about level of nostril, and thence proceed forward as an obsolescent median ridge on snout. Superolateral ridge of snout diverging posteriorly, at about an eye-diameter in front of orbit, to enclose subtriangular depression, in which nostril lies; inferolateral extending to about level of hinder orbital margin; medioventral feebly developed near level of eye, in advance of which it rapidly tends to become obsolete. Minute ridge on occiput and nape. Operculum without ridge, but with radiating striae.

Dorsal fin barely encroaching on third annulus in advance of that bearing vent, terminating on anterior half of seventh caudal annulus; base subequal to combined eye and snout; height subequal to eye. Length of pectoral 1.5 times width of its base, or about half postorbital of head. Anal minute. Caudal rounded, its length 5.1 in snout.

Head minutely punctulate, and vermiculately ridged and channelled. Body-scutes with pattern of delicate ridges (not shown in figure). (1) Median row of scutes each with lyrate pattern in lower four-fifths, junctioning with fan of ridges in upper fifth: upper row with fan in lower two-thirds, and less developed fan in upper third: other rows with pattern resembling karyokinetic spindle.

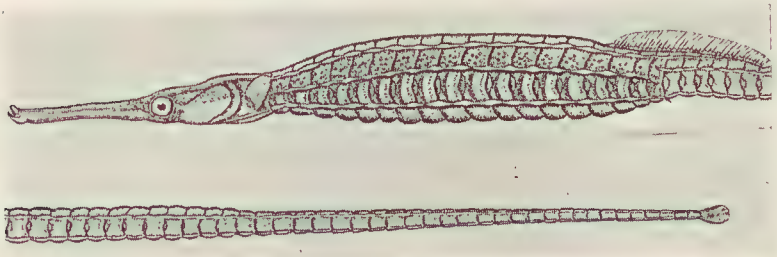

Fig. 1.—*Leptonotus semistriatus* Kaup. Total length 216 mm.
(For convenience in reproduction, this figure has been cut in two. The upper figure shows the anterior half of the fish, and the lower figure shows the posterior half.)

General colour in alcohol greyish yellow, becoming somewhat lighter below; brownish band extending from near middle of snout, across upper half of operculum and along upper lateral row of body-scutes; whitish stripe from eye, across opercle, to base of pectoral; brownish mid-dorsal stripe from about level of nostril to origin of dorsal; upper half of tail darker than lower; scattered whitish ocelli on upper lateral row of body-scutes.

Described and figured (text fig. 1) from a Victorian specimen, 216 mm. in total length, in the collection of the National Museum, Melbourne.

Comparison with Holotype.—Original description is short; but notes six dimensions. Kaup's measurements yield head 6.4, depth 14.0, tail 1.8 in total length; snout 1.7 in head; width of body 3.4 in its

(1) Remarking, regarding this pattern, 'The bands are transverse, (*fasciae*), and not longitudinal (*striae*)', Günther (1870), p. 162, footnote) suggested the emendation of Kaup's specific name *semifasciatus* to *semistriatus*.

depth: these proportions agree well with those noted above, but present specimen has noticeably wider body. One ray fewer in pectoral of present specimen is negligible; but I find only 5 caudal rays, as against 10 noted for holotype. Total annuli agree; but holotype has one fewer trunk, and one more caudal, annulus. The difference in number of subdorsal annuli on trunk is probably a question of mode of counting: formula given above includes the annulus on to which dorsal base barely encroaches; Kaup quite probably adopted the legitimate convention that this minor extension cephalad should be discounted.

Family ARRIPIDAE

Of the two Australian members of the family—*Arripis georgianus* (Cuvier and Valenciennes, 1831), *A. trutta* (Bloch and Schneider, 1801)—the latter only has hitherto been recorded from Tasmania: the former is here noted for the first time from our waters.

Key to Arripidae Recorded from Tasmania

D. IX, 14.—Body decidedly rough[1]; its depth > length of head. Two well-developed opercular spines. Basal portion of scale with fine striations parallel with anterior border, but no longitudinal ridges.[2] Without brassy trout-like spots on side ..... *A. georgianus.*

D. IX, 15-17 (usually 16). Body virtually smooth; its depth < length of head. Opercular spines obsolescent. Basal portion of scale with fine striations parallel with anterior border, and with several longitudinal ridges. Specimens up to about 10 inches, or more, in total length with several rows of conspicuous brassy trout-like spots on side ..... *A. trutta.*

Genus **ARRIPIS** Jenyns, 1840

Arripis georgianus (Cuvier and Valenciennes, 1831)

Centropristis georgianus Cuvier and Valenciennes, *Hist. Nat. Poiss.* VII. 1831. p. 451.

Arripis georgianus Jenyns, *Zool. Voy. Beagle, Fish.* 1840. p. 14.

Record.—Specimen (Reg. No. 917FR) of total length 251 mm., standard length 196 mm., caught near George Town by Mr. C. Andrews on 18th March, 1937; forwarded to the Museum by Mr. G. R. F. Green. I am informed by Mr. Green that about ten days before half a dozen specimens were included among a consignment sent to the Launceston Fish Market from the Islands Straits. First record for Tasmania.

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[1] Hence the vernacular name of *Roughy*, or *Tommy Rough*: also called *Wankaldi.*

[2] Name of genus based on absence in genotype of the customary fan-system of ridges on basal portion of scale. In *A. trutta*, however, there is a suggestion of the fan in the shape of three or four subparallel ridges.

Remarks.—From a consideration of the known habits and geographical range of the genotype, I have long thought it probable the present species visits, upon occasion, the northern waters of Tasmania: it is now some years since I first requested various observers to keep a sharp lookout for this species, and it is an interesting and pleasing circumstance that Mr. Andrew's keenness has resulted in its addition to the Tasmanian list.

Arripis trutta (Bloch and Schneider, 1801)

Sciena trutta Bloch and Schneider, *Syst. Ichth.* 1801. p. 542: *ex* Forster MS.

Arripis trutta McCulloch, *Mem. Aust. Mus. Sydney.* V. II. 1929. p. 200 (references and synonymy).

Remarks.—Known from New Zealand, Lord Howe Island, Norfolk and Raoul Islands, and from all the Australian States, first record for Queensland being noted recently by Whitley (1937, p. 135).

One of the commonest fishes in Launceston shops: great majority of individuals 200-300 mm. in total length; but examples reaching a length of about 500 mm. are not rare.

Vernacular names, as given in the books, include; Salmon; Salmon Arripis (McCoy, 1878); Australian, Native, or Colonial Salmon; Sydney Salmon (Stead, 1906); Kahawai (Phillipps, 1927); Salmon Trout (young); Newfish (young) (Stead, 1906). In Launceston fish-shops this species is usually sold under the name of Salmon, Blackback Salmon, Cocky Salmon (*Cocky*, an Australian farmer), Cock-Eye or Cock-Eyed Salmon (presumably a corruption resulting from misapprehension of preceding name), or Salmon Trout (young).

It is of interest to note that in July, 1934, there was received at the Museum a specimen of *Squilla sp.*, 110 mm. long, taken intact from the stomach of a specimen of *Arripis trutta* caught near George Town, Northern Tasmania.

Family BLENNIIDAE, *sensu lato*

Like many of our small fishes the Tasmanian Blennies are much in need of revision: while it is at present impracticable to solve all problems presented by the group, it is hoped the present observations may at least to some extent clear the ground for future progress.

The members of the family Blenniidae, *sensu lato*, including those forms segregated by many modern authors as belonging to the family Clinidae, accredited to Tasmania in the Australian Check-List (McCulloch, 1929) number seven species: (*a*) *Blennius tasmanianus* Richardson, 1839; (*b*) *Gillias clarkei* (Morton, 1888); (*c*) *Clinus perspicillatus* Cuvier and Valenciennes, 1836; (*d*) *Clinus johnstoni* Saville Kent, 1886; (*e*) *Petraites incertus* McCulloch, 1915; (*f*) *Cristiceps australis* Cuvier and Valenciennes, 1836; (*g*) *Cristiceps forsteri* Castelnau, 1872. One other species described from Tasmania,

Clinus despicillatus Richardson, 1839 (type-locality Port Arthur, Southern Tasmania), has long been regarded as an undoubted synonym of *C. perspicillatus*, and calls for no further comment here.

Modifications of this list adopted here comprise (*a*) addition of *Orphiclinus greeni* Scott, 1936 (described since publication of Check-List); (*b*) addition of *Gillias macleayanus* (Lucas, 1891) (first Tasmanian record—with redescription and figure—below); (*c*) restoration of *Gillias clarkei* (Morton) to the genus, *Tripterygion*, in which it was placed by its author; (*d*) relegation of *Petraites incertus* McCulloch to the synonymy of *P. forsteri* (Castelnau).

Notes are given on specimens of *Ophiclinus greeni* from a new locality, and on the appearance in early local lists of *Salarias maleagris* Cuvier and Valenciennes, 1836.

Key to Blenniidae and Clinidae Recorded from Tasmania

1. Much elongated; depth > 6 in length to hypural. Pectoral fin extending halfway, or less, towards vent. One continuous dorsal fin .... (2)
   Less elongated; depth < 6 in length to hypural. Pectoral fin extending more than halfway towards (sometimes beoynd) vent. Two or three more or less distinct dorsal fins, which may be connected or separate .... (3)

2. One continuous dorsal fin, consisting almost entirely of spines; approximately of even height throughout. Body with small, imbedded, non-imbricating scales. Pectoral fin larger than eye .... *Ophiclinus*
   D. XLVIII-XLIX, 1. A. III, 31-32. Total length about 70mm. .... *O. greeni*

3. Two dorsal fins; first consisting of spines, second either wholly of soft rays, or chiefly of spines with a few soft rays. Body naked, or with small, more or less imbedded, non-imbricating scales .... (4)
   Three distinct dorsal fins; first and second consisting of spines, third of soft rays. Body with well-developed, normal, imbricating scales .... (8)

4. Body naked. The two dorsal fins closely connected by membrane, point of junction being indicated by notch in external margin of fins. First dorsal with about 12 spines. Second dorsal with about 18 soft rays; its base < 2 base of first dorsal. In lower (and upper) jaw a single posterior curved canine on each side; rest of teeth long, slender, in contact with each other throughout most of their length, forming a palisade-like row .... *Blennius*
   D. XII, 17-19. A. II, 18-20. Total length about 110mm. .... *B. tasmanianus*
   Body with rudimentary or small, non-imbricating scales. The two dorsal fins partly connected by membrane, or separate. First dorsal with 3, rarely 2, spines. Second dorsal with about 25-35 spines, followed by about 2-8 soft rays; its base > 4 base of first dorsal. In each ramus of lower jaw a symphysial patch of villiform or cardiform teeth, followed laterally by larger, well-separated teeth in one or more rows .... (5)

5. First dorsal spine placed over, or in front of, eye ... . *Cristiceps*
First dorsal spine placed rather behind middle of eye; about twice third spine. First and second dorsal fins sometimes connected by membrane, sometimes separate. Soft rays of second dorsal equidistant. D. III, XXVI-XXIX ; 6-8. A. II, 24-26. Total length about 100mm. .... *C. australis*
First dorsal spine placed behind eye .... (6)

6. Last (third or second) spine of first dorsal connected by membrane to middle, or upper half, of first spine of second dorsal .... *Clinus* (7)
Last (third) spine of first dorsal connected by membrane to basal portion only of first spine of second dorsal .... *Petraites*
First dorsal spine placed less than one eye-diameter behind orbit; about twice third spine. Maxillary extending to level of posterior orbital margin. Snout about 1.5 eye. D. III, XXIX ; 4-5. A. II, 23-24. Total length about 250mm. .... *P. forsteri*

7. First dorsal spine placed less than one eye-diameter behind eye; subequal to third spine. Maxillary not extending to level of posterior orbital margin. Snout rather shorter than eye. In lower jaw lateral teeth not much larger than anterior teeth of the cardiform symphysial patch. D. III, XXII-XXIV ; 3-5. A. II, 24-26. Total length about 100mm. .... *C. perspicillatus*
First dorsal spine placed more than one eye-diameter behind eye; subequal to third spine. Maxillary extending beyond level of posterior orbital margin. Snout rather longer than eye. In lower jaw lateral teeth many times larger than teeth of the villiform symphysial patch. D. II-III, XXXII-XXXIII; 5-6. A. II, 25-26. Total length about 375mm. .... *C. johnstoni*

8. Head naked .... *Tripterygion*
Scales large ; head scaleless. Lateral line terminating below eighth ray of third dorsal. Teeth villiform; several maxillary caniniform. D. III, XVI, 11. A. 23. Total length about 75mm. .... *T. clarkei*
Head partly scaly .... *Gillias*
Scales on body (except pectoral base), occiput, preoperculum (part), operculum (part) ; ctenoid, except on breast, where they are cycloid. Lateral line following curve of back to level of fourth (? eighth) ray of third dorsal. Teeth in jaws subequal. D. III, XIV, 10-12. A. 22. Total length about 75mm. .... *G. macleayanus*

Genus **Petraites** Ogilby, 1885

Petraites forsteri (Castelnau, 1881)

Cristiceps forsteri Castelnau, *Proc. Zool. Acclim. Soc. Vict.* i. 1872. p. 132.

Petraites incertus McCulloch, *Proc. Linn. N.S.W.* xl. 2. 1915. p. 275. pl. xxxvii. fig. 3.

Remarks.—Though *Cristiceps forsteri* Castelnau appears under the genus *Cristiceps* Cuvier and Valenciennes, 1836, in the Australian Check-List, it is clearly referable to *Petraites* Ogilby, 1885, as delimited by McCulloch (1908, p. 37).

In concluding some observations on *Petraites incertus* McCulloch, the type locality of which is River Tamar, Tasmania, I quoted (1935b, p. 71), and subscribed to, McCulloch's statement regarding the relationship exhibited by specimens of *Petraites incertus* to descriptions of some of the early, imperfectly characterized members of the genus, 'they do not wholly agree with any of the descriptions' (McCulloch, 1915, p. 276). In the course of preparing the key given above, however, I found myself unable to distinguish satisfactorily between *Cristiceps forsteri* Castelnau and *Petraites incertus* McCulloch. The former species is said by Johnston (1883, p. 121) to be common: I have, however, not seen specimens identified as Castelnau's species, and Dr. Joseph Pearson, Director, Tasmanian Museum, Hobart, and Mr. George Mack, Ichthyologist, National Museum, Melbourne, inform me that there are no specimens thus labelled in the collections of their respective institutions. On the other hand, examples clearly determinable as *Petraites incertus* McCulloch appear to be by no means uncommon in Tasmania. I think it likely, therefore, that McCulloch's account of *P. incertus* represents a redescription of Castelnau's species; and, on available evidence, it seems a step forward in our gradual progress towards clarification of the obscurity still largely enveloping our Blennies to sink the former species in the synonymy of the latter.

As *Cristiceps forsteri* the species is known from Victoria and Tasmania: under McCulloch's name it is recorded only from Tasmania, the only accounts of it apparently being the original description and the notes contained in an earlier part of the present series of observation.

Genus **Tripterygion** Risso, 1826

Tripterygion clarkei Morton, 1888

Triptergium clarkei Morton, *Pap. Roy. Soc. Tasm.* 1887 (1880). p. xlvii and p. 78. *Id.* Hall, *Pap. Roy. Soc. Tasm.* 1912 (1913), p. 82.

Gillias clarkei McCulloch, *Mem. Aust. Mus. Sydney.* V. III. 1929. p. 348. Probably not *Gillias clarkei* Whitley, *Pap. Roy. Soc. Tasm.* 1929 (1930), p. 65: *ex* Johnston MS.

Remarks.—Originally described in the genus *Tripterygium* [= *Tripterygion*] Risso, 1826, this species is referred in the Australian Check-List to *Gillias* Evermann and Marsh, 1900. It should, however, probably not be placed in the latter genus. Thus *Gillias*—*fide* McCulloch (1927), p. 86)—has head scaly, whereas original description of species states 'head scaleless'; again, *Gillias* is noted (Jordan and Evermann, 1900, p. 3186) as having D. III; XI; 7, as against III; XVI; 11 in Morton's species. It is doubtful if our present knowledge of this fish is adequate for a definite generic determination: pending the acquisition of further data, it is here provisionally restored to the genus in which it was placed by its author.

I can find only four references, apart from entries in faunal lists, to this species: (*a*) a note in the journal of this Society that apparently records the exhibition of the holotype at the meeting of 15th August, 1887; (*b*) original description (Morton, 1888, p. 78); (*c*) some observations by Hall (1913, p. 82) on coloration, based on some twenty specimens, 1.5-3 inches long, captured 'among the piers, Hobart, August, 1909'. Hall states later (p. 84) that specimens mentioned in his paper 'will be additions to the Tasmanian Museum,' but Dr. Pearson, who has kindly made a search at my request, informs me this material cannot now be traced; (*d*) Whitley (1929, p. 65) quotes a short description of 'Blenny, *Tripterygium sp.*' from Leven, from Johnston MS, and refers this fish to *Gillias clarkei*. From Johnston's description, however, I very much doubt if his specimen is conspecific with Morton's. It is quite possible the specimen noted in Johnston's MS is that mentioned in the following sentence occuring in the Proceedings for August, 1887: 'Mr. Morton also submitted a new species of the genus *Tripterygium*, a genus hitherto unrecorded in Tasmania, although Mr. Johnston had a specimen, of a different species, but had not described it.' Johnston's memorandum (Whitley, 1929, p. 65) notes D. 21/8, *i.e.*, presumably, III.; XVIII; 8, which seems decidedly different from Morton's D. III.; XVI. 11.

Genus **Gillias** Evermann and Marsh, 1900

Gillias macleayanus (Lucas, 1891)

(Text fig. 2)

Tripterygium macleayanus Lucas, *Proc. Roy. Soc. Viet.* (n.s.). iii. 1890 (1891). p. 9 and p. 12. pl. III. fig. 4.
Gillias macleayanus McCulloch, *Mem. Aust. Mus. Sydney.* V. III. 1929, p. 348.

Record.—Specimen (Reg. No. 918FR) collected in rock pool at mouth of Currie River, Northern Tasmania, by Mr. G. R. F. Green, 30th January, 1936. First record for Tasmania.

Generic Status.—*Tripterygium macleayanus* Lucas is referred in the Australian Check-List (McCulloch, 1929) to the genus *Gillias* Evermann and Marsh, 1900, and this procedure is provisionally followed here. I have not access to the original description of the genus, but perusal of a diagnosis published a few months later by Jordan and Evermann (1900), which Mr. George Mack, Ichthyologist, National Museum, Melbourne, has been good enough to transcribe for me, suggests this attribution is doubtful. In the light of modern developments, including the description by McCulloch and Waite (1918) of several endemic South Australian genera, the generic status of various Australian Blennies at present referred to this genus, to *Tripterygion* Risso, 1826, and to allied genera appears to call for revision, a task for which literature and material available here are unfortunately inadequate. The possibility that this species is a synonym of *T. clarkei* Morton should not be altogether overlooked.

Remarks.—Hitherto known only from Victoria. The fairly short original description and small outline figure, based on a single specimen, 50 mm. long, from the Bracebridge Wilson material of 1888-9, do not seem since to have been supplemented: a redescription and a figure (Text fig. 2) are here offered.

Description.—Br. vi. D. iii; xiv; 10. A. i, 21. P. 12 + 6. V. 2. C. 13 + $\frac{1}{4}$. Depth of body at vent 6.3 in total length, 5.2 in standard length. Head 3.8, length to vent 2.3, in standard length. Interorbital width 4.9 in eye, which is 3.4 in head. Snout 1.4 in eye, 4.6 in head. Depth of caudal peduncle greater than its own length, 3.1 in head.

Head large, subconical, its depth 1.3 in its width; naked, except for small ctenoid scales that extend forward on occiput to level of the orbital tentacle, on to whole width of upper fifth of preoperculum, and on to anterior two-thirds of upper half of operculum. Numerous well-developed pores, including double closely set row below eye, two mesial rows on dorsal surface of snout, fairly widely spaced row fringing preoperculum, about half a dozen below on each ramus of mandible: none on operculum. Anterior nostril tubular, broader than high, equidistant from orbit and upper lip, at 9 o'clock relative

Fig. 2.—*Gillias macleayanus* (Lucas). Total length 53.75mm.

to eye (left aspect); surmounted by divided subtriangular flap. Posterior nostril a simple opening, close to orbit, at about 11 o'clock. Small hand-shaped ocular tentacle at about 1 o'clock. Row of minute fringed papillae above and behind orbit. Eye large, cutting dorsal profile, longer than high, set obliquely, its major axis at about 45° to the horizontal. Interorbital space slightly concave, with median depression, in hinder half; almost flat in anterior half. Lips large and thick, markedly protuberant, upper projecting slightly beyond lower; maxillary reaching to below hinder third of eye. Maxillary teeth uniserial, subconical, subequal; broad villiform vomerine arc; anterior portion of palatines with clustered large mammillary teeth; mandibular teeth in fairly broad cardiform patch near the symphysis, becoming uniserial laterally.

Body stout, its width at shoulder subequal to its height there, at origin of third dorsal about half its height there. Except for the pectoral base, wholly covered with scales, which are small and cycloid on breast, large and finely ctenoid on sides: 34 rows of scales from axilla to hypural, beyond which are one or two rows on bases of caudal rays. Counting obliquely backwards from origin of first dorsal, rows of scales number 3/1/8; or, from origin of third dorsal to base of anal, 2/1/5 (1). Lateral line subparallel with dorsal profile, from which it is distant about one-fourth as far as from ventral profile; continued to below fourth ray of third dorsal (25 scales), with indication of extension (specimen damaged) to below eighth ray of third dorsal (29 scales). A slight mediolateral groove, apparently without perforations, extends forward from caudal base to level of about eighth ray of third dorsal.

First dorsal fin originating about midway between levels of preopercular and opercular margins; length to origin 4.2 in standard length; base 3.8 in head, about half combined eye and snout; first, second, third spines respectively 32, 35, 29% of head. Interspace between first and second dorsals 5.0 in snout, slightly less than interorbital width. Second dorsal originating shortly behind level of upper angle of pectoral base; length to origin 3.1 in standard length; base 1.3 times head, subequal to length from anterior margin of eye to vent; first, ninth, (longest), fourteenth spines respectively 35, 45, 20% of head. Second interorbital space subequal to first Third dorsal with the first five rays very feebly and briefly divided, the sixth, eighth, and tenth, which are the only undamaged rays of the remainder, simple; originating about as far behind vent as vent is behind pelvics, terminating about above penultimate anal ray; length to origin 1.5 in standard length; base 1.3 in head, subequal to depth of body; first, sixth (longest), tenth rays respectively 37, 49, 30% of head; laid back, fails to reach level of base of caudal rays by less than an eye-diameter. Anal with all rays simple, much stouter than those of the third dorsal, the membrane incised to a depth of more than one-third length of the rays; originating below sixth spine of second dorsal; length to origin 2.2 in standard length; base 1.8 times head, subequal to length to origin of the fin; extending behind end of third dorsal by twice interorbital width; spine, first, eleventh, twenty-first (longest), twenty-second rays respectively 12, 21, 43, 46 30% of head; laid back, extends slightly beyond base of caudal rays. Pectoral long, pointed; with upper rays slender, divided in their outer third or half; lower rays, between which membrane is markedly incised, not divided distally, but with the rib appearing as two separate ridges in the proximal two-thirds or four-fifths; originating

(1) The former convention is evidently that adopted in the original description of the present species (Lucas, 1891): the latter permits of comparison with the description of species ascribed to *Tripterygium* by Ramsay and Ogilby (1888a; 1888b).

behind pelvics by about an eye-diameter; length to origin 3.9 in standard length; longest (tenth) ray 1.2 times head; laid back, reaches to below penultimate spine of second dorsal. Ventral with the stout simple rays separate for nearly their whole length; originating about below preopercular margin, four-fifths of length of snout in advance of dorsal origin; length to origin 5.1 in standard length; outer, more anterior ray 1.3 in inner, more posterior ray, which is 1.2 in head. Caudal with all major rays branched up to nearly half their length, except lower two rays, which are simple, and decidedly stouter than upper two; length of median rays 4.4 in standard length, 1.2 in head.

Genital papilla moderate, longitudinally plicate.

General colour in formalin yellowish-grey, becoming flesh-coloured on the anterior half of the preanal ventral surface. About eight subvertical dark-brown bars, best developed anteriorly; first immediately behind pectoral base, second and third below second dorsal, fourth below interspace between second and third dorsals, fifth and sixth below third dorsal, seventh near middle of caudal peduncle, eighth at base of caudal rays: eight similarly coloured saddles on back, five posterior continuous with the lateral bars, the three anterior ones from third increasingly in advance of corresponding bars. General colour of head dark greyish-brown dorsally and laterally, concolorous ventrally with sides of body. Two conspicuous light-coloured, dark-bordered genal bands, running downwards and backwards from front and rear of lower edge of orbit: a less conspicuous, similarly coloured, band fringing preoperculum, preceded by dark band. Dark patch below eye; broad dark band extending forward from front of eye across upper lip, the latter elsewhere dark greenish-brown; tip of snout brown, the colour continued back as a narrow stripe to interorbital region. Lower lip concolorous mesially with throat, darker laterally. Eye greyish-blue. Dorsal fins greyish, heavily speckled on membrane and spines, and to lesser degree on rays, with dark brownish; first and second dorsals narrowly fringed with blackish along free margin. Anal greyish, less heavily punctulated than dorsals; tips of rays whitish. Pectoral greyish, the membrane lightly, the rays, especially at base, heavily, punctulated with brownish. Pelvic whitish. Caudal pale greyish, moderately dotted with brownish on membrane, slightly on rays.

Described and figured (Text fig. 2) from a specimen of total length 53.75 mm., standard length 43.75 mm., in the collection of the Queen Victoria Museum (Reg. No. 918FR).

Variation.—Examination of a range of specimens may show this fish is distinct from Lucas' species: with only one individual available, it seems advisable for the present to assume identity.

Chief differences from holotype exhibited by present specimen; two fewer rays in third dorsal; three more rays in pectoral; rather smaller eye; level of anal origin further forward along base of second dorsal than shown in Lucas' figure.

The marked differences in coloration—the holotype (in spirit) is described as orange, with red vertical bands; eye red—are probably attributable to the use of different media for preservation: attention has previously been called (Scott, 1936, p. 123) to variations in colour of blennies in alcohol and formalin (1).

Family OPHICLINIDAE

Genus **Ophiclinus** Castelnau, 1872

Ophiclinus greeni Scott, 1936

Ophiclinus greeni Scott, *Pap. Roy. Soc. Tasm.* 1935 (1936), p. 114, fig. 1.

Record.—Two specimens, of total length 75.0, 62.0 mm., standard length 68.0, 56.5 mm. (Reg. No. 806, a-b), collected in rock pools at mouth of Currie River, Northern Tasmania, by Mr. G. R. F. Green, on 3rd January, 1936.

Remarks.—The species has hitherto been known only from the holotype and two paratypes, the type-locality being Lady Lucy Beach, Low Head, Northern Tasmania. In addition to providing a new locality, the present specimens are of importance in that they both considerably exceed in size the largest specimen previously known—larger individual is one and a half times as long as larger paratype, which has total length 49.8 mm., standard length 45.5 mm.—and afford some interesting data regarding variation of proportion with general size.

Proportions.—Large individual noted first [values in square brackets show range exhibited by holotype and two paratypes, 34.3-49.8 mm. in total length, 31.9-45.5 mm. in standard length]. Depth 7.7, 8.8 [7.7-8.2] in total length; 7.0, 8.1 [6.4-7.5] in standard length: depth at level of first anal ray 7.9, 9.3 [7.7-8.9] in total length; 7.2, 8.4 [6.9-8.1] in standard length. Head 6.4, 6.1 [4.9-5.7] in total length; 5.8, 5.5 [4.4-5.2] in standard length. Eye 6.5, 6.4 [5.3-6.1] in head; 1.5, 1.4 [1.2-1.5] in snout; 1.3, 1.1 [1.1-1.2] in tail without caudal fin.

It will be seen that with increase in size of the fish are correlated decrease in length of head, relative to total, or to standard, length; decrease in diameter of eye, relative to length of head; and decrease of combined length of head and trunk, relative to tail without caudal fin. The first two variations are, of course, characteristic of many fishes; and there is evidence to show that, with advancing age, increase of length of the postanal, relative to the preanal, portion of the body is not uncommonly encountered in Blenniid fishes.

Maxillary extends to level of middle (smaller specimen), or hinder four-fifths (larger specimen), of eye.

(1) Recently Myers (1936, p. 83) has discussed the significance in certain Albulid fishes of longitudinal dark stripes observed in formalin specimens, the presence or absence of which is possibly connected with the nature of the preservative used.

Fin-Formulae.—Larger individual noted first. D. XLVIII, 1; XLIX, 1. A. III, 32 (both specimens). P. 12; 11. V. 2 (both) C. 13 + $\frac{2}{2}$; 13 + $\frac{2}{1}$.

Genus **Salarias** Cuvier, 1829

Salarias meleagris Cuvier and Valenciennes, 1836

Salarias meleagris Cuvier and Valenciennes, *Hist. Nat. Poiss.* XI. 1836. p. 332.

Remarks.—Type-locality is given as 'Terre de Van-Diemen' (Péron); and the species is included by Johnston in both his Tasmanian lists, since which, however, it has been dropped from all local catalogues. In their review of some Australian Blennioid Fishes McCulloch and McNeill state (1918, p. 17): 'This species was said to have been originally obtained by Péron in Tasmania, but no species of the genus occurs so far south. Johnston (1883, p. 121) noted that it was common in Tasmanian waters, but his reference doubtless applied to *Blennius tasmanianus*.' In the Australian Check-List the Australian range is given as Queensland, Northern Territory.

The comment made by McCulloch and McNeill regarding the confounding on Johnston's part of this species with *Blennius tasmanianus* Richardson, 1849, may perhaps appear a rather sweeping and overfacile one: it is, I believe, nevertheless, almost certainly correct. As the result of examination of a considerable number of specimens of *Blennius tasmanianus*, I find that while in the majority the conformation of the anterior portion of the head is much that shown in the well-known figure by Waite (1906, pl. XXXVI. fig. 5)—*i.e.*, dorsal profile of snout sloping backwards at about 45°; snout little less than, often greater than, eye; mouth-cleft markedly oblique (about normal to dorsal profile of snout), reaching to about middle of eye—occasional individuals have a decidedly *Salarias*-like facies, the dorsal profile of the snout being subvertical, making length of snout barely more than half eye, and bringing mouth-cleft, which now extends about to posterior orbital margin, virtually horizontal.

Family GOBIIDAE

A recent revision of the Tasmanian members of the family (Scott, 1935a) credits our fauna with three species, representing as many genera: *Nesogobius hinsbyi* (McCulloch and Ogilby, 1919); *Arenigobius tamarensis* (Johnston, 1883); *Tasmanogobius lordi* Scott, 1935.

A note on *Arenigobius tamarensis* appears below, and a key to the local gobies is supplied.

Key to Gobiidae Recorded from Tasmania

1. Body with well-developed normal scales. Second dorsal with < 12 rays; its base < 2 (about 1½) base of first dorsal .... (2)
   Body without normal scales. Second dorsal with > 12 rays; its base > 2 (about 2½) base of first dorsal .... (3)

2. Rows of scales between axilla and hypural < 40. Tongue notched anteriorly. Spines of first dorsal never > 6 .... *Arenigobius* D. VI, 9. A. I, 8 . Rows of scales between axilla and hypural 32-33. General colour greenish-grey or greyish-brown, becoming whitish or pale greenish-grey below; vertical bars on side, if present, about 4, not descending below midlateral line .... *A. tamarensis*

Rows of scales between axilla and hypural > 40. Tongue rounded anteriorly. Spines of first dorsal usually > 6 .... *Nesogobius* D. VII (rarely VI)-VIII, 9-12. A. I, 8-11. Rows of scales between axilla and hypural 50. General colour sandy above midlateral line, white below; usually about 12 narrow subvertical bars on side, often descending below midlateral line .... *N. hinsbyi*

3. Body with pectinate groups of microscopic spines, arranged in staggered rows, often invisible without dissection .... *Tasmanogobius* D. VI-VII, 15-16. A. I, 13-15. In life virtually transparent, with small fawn markings .... *T. lordi*

Genus **Arenigobius** Whitley, 1930

Arenigobius tamarensis (Johnston, 1883)

Gobius tamarensis Johnston, *Pap. Roy. Soc. Tasm.* 1882 (1883), p. 120.

Arenigobius tamarensis Scott, *Pap. Roy. Soc. Tasm.* 1934 (1935). p. 50. pl. IV. fig. 1 (references and synonymy).

Record.—This species, which appears to have remained unrecognised during the fifty-odd years between the publication of the original description and the provision of a redescription and figure in the revision of the Tasmanian Gobiidae cited above (Scott, 1935a), has hitherto been know only from the type-locality, River Tamar, Northern Tasmania.

It may now be recorded from the East Coast, two specimens of total length 51, 58 mm., standard length 41, 47 mm. (Reg. Nos. 943, a-b) being included in a sample of 'Prettyfish' collected at Swansea by Mr. H. W. A. von Stieglitz: received 18th December, 1934. 'Prettyfish,' it may be observed, is a collective term for various small fishes used as bait at several fishing resorts on the East Coast. The constituent species not improbably vary with locality and season: in the present instance, the two gobies are associated with 14 specimens of *Atherina microstoma* Günther, of total length 49-72 mm., av. 59 mm.

Summary

1. Some general observations are made on *Arripis trutta* (Bloch and Schneider, 1801), *Petraites forsteri* (Castelnau, 1881), *Petraites incertus* McCulloch, 1915, *Tripterygion clarkei* Morton, 1888, *Ophiclinus greeni* Scott, 1935, *Arenigobius tamarensis* (Johnston, 1883).

2. Little-known species described and figured are *Leptonotus semistriatus* Kaup, 1856, *Gillias macleayanus* (Lucas, 1891).

3. Additions to the Tasmanian faunal list comprise *Leptoichthys fistularius* Kaup, 1853, *Arripis georgianus* (Cuvier and Valenciennes, 1831).

4. The inclusion in the local lists of *Corythoichthys phillipi* (Lucas, 1891), *Salarias meleagris* Cuvier and Valenciennes, 1836, is discussed.

5. Keys are supplied to the Tasmanian members of the families Syngnathidae, Arripidae, Blenniidae, Gobiidae.

References

Günther, A., 1870.—*Catalogue of Fishes in the Collection of the British Museum.* vol. VIII.

Hall, R., 1913.—Notes on Derwent Estuary Fishes. *Pap. Roy. Soc. Tasm.* 1912 (1913). pp. 79-84.

Johnston, R. M., 1883.—General and Critical Observations on the Fishes of Tasmania . . . *Pap. Roy. Soc. Tasm.* 1882 (1883). pp. 53-144.

Jordon, D. S. and Evermann, B. W., 1900.—Fishes of North and Middle America. *Bull. U.S. Nat. Mus.* 47. 4.

Kaup, J. J., 1856.—*Catalogue of the Lophobranchiate Fish in the Collection of the British Museum.*

Lord, C. E., and Scott, H. H., 1924.—*A Synopsis of the Vertebrate Animals of Tasmania.* Hobart.

Lucas, A. H. S., 1891.—On the Occurrence of Certain Fish in Victorian Seas, with Descriptions of some New Species. *Proc. Roy. Soc. Vict.* III. (n.s.). 1890 (1891). pp. 8-14. pl. III.

McCoy, F., 1878.—*Prodromus of the Zoology of Victoria.* Dec. II. Melbourne.

McCulloch, A. R., 1908.—Studies in Australian Fishes. No. 1. *Rec. Aust. Mus. Sydney.* VII. 1. pp. 36-43. pl. X-XI.

———————, 1911.—*Zoological Results . . . F. I. S. Endeavour . . . Fishes.* Part 1. Sydney.

———————, 1915.—Notes on, and Descriptions of Australian Fishes. *Proc. Linn. Soc. N.S.W.* XL. 1915. pp. 259-277. pl. XXXV-XXXVII.

———————, 1929.—A Check-List of the Fishes Recorded from Australia. *Mem. Aust. Mus. Sydney.* V. Parts I-III. (part IV, Index, 1930).

McCulloch, A. R., and McNeill, F. A., 1918.—Some Australian Blennioid Fishes. *Rec. Aust. Mus. Sydney.* XII. 2. pp. 9-25. pl. III-IV.

Mack, G., 1934.—New Records of Fishes from Victoria. No. 1. *Vict. Nat.* LI. 8. pp. 179-180.

Morton, A., 1888.—Description of Two New Fishes. *Pap. Roy. Soc. Tasm.* 1887 (1888). pp. 77-78.

Myers, G. S., 1936.—A third Record of the Albulid Fish *Dixonina nemoptera* Fowler, with Notes on an Albulid from the Eocene of Maryland. *Copeia.* II.

Phillips, W. J., 1927.—Bibliography of New Zealand Fishes. *N.Z. Fish. Bull.* 1. pp. 1-68.

Ramsay, E. P., and Ogilby, J. D., 1888a.—Descriptions of Two New Fishes from Port Jackson. *Proc. Linn. Soc. N.S.W.* (2). II. 4. pp. 1021-1023.

———————— 1888b.—Description of a New *Tripterygium* from Port Jackson. *Proc. Linn. Soc. N.S.W.* (2). III. 2. pp. 419-420.

Scott, E. O. G., 1934.—Observations on Some Tasmanian Fishes, with Descriptions of New Species. *Pap. Roy. Soc. Tasm.* 1933 (1934). pp. 31-53. pl. VI-VIII. text-figs. 1-2.

———————, 1935a.—Notes on the Gobies Recorded from Tasmania, with Description on a New Genus. *Pap. Roy. Soc. Tasm.* 1934 (1935). pp. 47-62. pl. IV. text-figs. 1-2.

———————, 1935b.—Observations on Some Tasmanian Fishes: Part II. *Pap. Roy. Soc. Tasm.* 1934 (1935). pp. 63-79. pl. V.

———————, 1936.—Observations on Some Tasmanian Fishes: Part III. *Pap. Roy. Soc. Tasm.* 1935 (1936). pp. 113-129. text-figs. 1-3.

STEAD, D. G., 1906.—*Fishes of Australia* . . . Sydney.

WAITE, E. R., 1906.—Description of and Notes on Some Australian and Tasmanian Fishes. *Rec. Aust. Mus. Sydney.* VI. 3. pp. 194-210. pl. XXXIV-XXXVI.

WAITE, E. R., and HALE, H. M., 1921.—Review of the Lophobranchiate Fishes (Pipe-Fishes and Sea Horses) of South Australia. *Rec. S. Aust. Mus. Adelaide.* I. pp. 293-324. text-figs. 39-56.

WHITLEY, G. P., 1929.—R. M. Johnston's Memoranda relating to the Fishes of Tasmania. *Pap. Roy. Soc. Tasm.* 1928 (1929). pp. 44-68. pl. II-IV.

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Note on Pleistocene Glaciation Mt. Field to Strahan

By

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(Read 14th November, 1938)

This paper is an attempt at a general correlation of Tasmanian glacial features along a section from east to west of the glaciated portion of the State. The area chosen for this survey has already been the subject of a number of detailed descriptions and the influence of ice on its topography has been known in part since Charles Gould's first record in 1861 and in detail since R. M. Johnston's account in 1893. The few new areas in which traces of glaciation are here recorded do little more than connect up previous accounts. This paper may be regarded as supplying examples in support of my correlation of Tasmanian Pleistocene Glacial epochs and deposits (Lewis 1934). I now confirm, with a few modifications, the ideas then advanced and am able to clear up points which I then felt to be open to some doubt.

1. Summary of Previous Accounts with New Records

Mt. Field

This area, on the eastern extremity of the glaciated zone, shows the typical topography of intense mountain glaciation down to the 2500 feet contour or a little less. It has been fully described (Lewis 1922 and 1923, Griffith Taylor 1922) and I have no further observations to record.

Florentine Valley

Previously, glaciation had been recognized to the east, south and west of this area but previous investigators had not recorded glaciation in the Florentine Valley itself. The reason for this has probably been that the Florentine is covered by dense virgin forest concealing the topographical details while the bare plains of the neighbour-

ing Gordon and Huon valleys display their glacial features to perfection. However, as the results of a visit at Christmastime 1937, I have no hesitation in saying that the upper half of the Florentine Valley was subject to glacial action as severe as was the Vale of Rasselas. This is to be seen clearly from the Adamsfield track on the northern slopes of Tim Shea, and as it crosses the Thumbs-Saw Back saddle. The headwater tributaries of the Florentine rise in a wide arc of cirques on the northern flanks of Mts. Mueller, Bowes and Wedge. The less heavily timbered upper portion of the valley south of the Adamsfield track shows a glacial topography not essentially different from that of the upper Huon and Gordon rivers. The Tiger and Gordon ranges show the typical planing action of a major glacier along both flanks, as do the lower slopes of Mt. Field West. Spurs have been shorn and the whole floor of the Florentine Valley, at least as far north as Dawson's Road, or even an east-west line through Wyld's Crag, shows all the typical features of glacial topography. Morainal deposits abound for miles on both sides of the Florentine bridge on the Adamsfield track. It appears at present that ice descended to at least the 900-foot contour and perhaps lower. There has however been considerable post-glacial river erosion below that level.

Russell Falls River Valley

Glacial action is apparent in the saddles on both sides of Tim Shea, on the slopes of the Needles and over Mt. Mueller where cirques and at least one tarn occur. There is some slight suggestion of ice action as low as Kallista (1100 feet) but stream erosion has been more active on the steeper slopes of this valley and I cannot definitely confirm glacial evidence below 1500-1600 feet in this area.

Weld Valley

There appears to be some slight remains of glaciation north west of Mt. Anne at, perhaps 1100-1500 feet. The head of the Weld-Styx valleys are heavily timbered and observations are difficult.

Adamsfield

This area is also glaciated, although the short swift tributaries of the Gordon (Adam, Boyd, &c.) have been responsible for a high degree of post glacial erosion (See also Nye 1929, A. M. Reid 1921).

Vale of Rasselas, Denison Range and King William Ranges

The Gordon Valley from its source in Lake Richmond, down to the Great Bend, and its bounding ranges are all excellent examples of Tasmanian glacial topography. The fact that the whole of this area was heavily glaciated has been known since R. M. Johnston's early investigation (See e.g. Johnston 1894, Twelvetrees 1908, Reid 1921).

The mountains are dotted with large lakes and small tarns and the Vale of Rasselas is glaciated to the Great Bend at 1550 feet. Below this spot the eastward erosion of the river which is now the westerly flowing section of the Gordon has destroyed evidence of ice action but the glacial topography is continued unbroken across the almost negligible saddle of Myrtle Creek to the Florentine Valley.

Lake St. Clair

This area has been fully described by several observers, particularly W. H. Clemes (Clemes 1925, and see references to previous works there cited). I have nothing to add to these accounts except the interesting fact, which came to light during the surveys for the Tarraleah Power Scheme, that the floor of Lake St. Clair (700 feet deep) is lower than the bed of the Derwent for 10 miles down its course, that is to the top of Butler's Gorge, where the post glacial erosion of the Derwent River cuts into the glacial physiography. Mr. Clemes's account connects with the adjoining area to the north east already described in detail my myself (Lewis 1933).

Surprise Valley

The West Coast Road has opened up a wonderful section of glacial country. In fact it was in this section that Charles Gould in 1861-2 first discovered the occurrence of pleistocene glaciation in Tasmania (? Australia, see Johnston 1894). For 65 miles, from the Clarence to Gormanston, this road traverses an unending vista of moraine strewn glacial valleys with cirques never out of view. The eastern portion of this area has been fully described (Clemes 1925 and other references there specified). From Derwent Bridge where the road crosses the lower portion of the St. Clair moraine to King William Saddle (2725 feet), the country is typical of the more open glaciated plateaux. From the road at King William Saddle is to be seen the cirque system at the head of the Surprise Valley. The road drops from 2725 feet on the saddle to 1200 feet at the junction of the Surprise and Franklin Rivers, and this marks the vertical height between the country affected by two glacial phases. The whole floor of these valleys is glaciated although this fact is partly obscured by the heavy growth of timber. The glacial evidences at the head of the Franklin River (Lakes Undine and Dixon) have been well described (Johnston 1894, Clemes 1925) but the Surprise Valley is no less intensely glaciated with a remarkable 'tind' in the middle. Under Mt. Arrowsmith and Mt. Hardy some fine examples of moraines are exposed in the road cuttings.

Collingwood Valley

The road runs along the bottom of a typical glaciated valley here. The northern slopes of the Collingwood and Raglan Ranges as seen from the road present, in a remarkably clear way, the W pattern

of shorn spurs. Hanging valleys and superimposed cirques can be seen everywhere. Glacial action extends right up to the top of the Collingwood-Nelson Saddle west of King Billy.

Nelson Valley

Here the road runs, at first, high up on the side of a typical glacial valley. The characteristic shorn spurs are seen, this time, from above. The road enters the Nelson Valley also over the crest of a cirque. No more typical example of glacial erosion can be seen anywhere.

King River

This valley has been the collecting ground for a large sheet of ice descending in many tributaries glaciers from all the surrounding mountains (See Johnston 1894). Its broad floor is now covered with morainal material largely restored by post-glacial floods.

Linda Valley

This short valley provides the most spectacular example of glacial topography in the whole State and the destruction of all vegetation and humus by firewood getters, sulphur fumes and heavy rains has revealed the rocks as much as the glaciers left them. This and neighbouring areas have been well described (Moore 1894, Gregory 1903, Hills 1914, David 1924 and Lewis 1936) and I have nothing further to add.

Queenstown

A remarkable change in topography presents itself as the Linda Gap is crossed from Gormanston on the road to Queenstown. The open vista of the perfect glacial valley crowned by the huge Gormanston moraine gives place to a confused jumble of waterworn gorges. These are the head waters of the Queen River, which have cut easterly into the western slopes of the West Coast Range and here have removed all trace of glacial topography. The same has occurred in the Comstock Gap to the north. (Nye and Blake 1938, p. 15). Evidence of ice action is again apparent in a tributary valley north of the saddle at Renedeena on the Mount Lyell Railway between Lynchford and Renedeena. In the valley of the King River, south of the saddle, the traces of glaciation have likewise been largely removed (See David 1924).

Strahan

It is clear that final confirmation of the various theories relating to superimposed glaciations must be sought at the edge of the glaciated area. Unfortunately this evidence has been destroyed in most localities by post-glacial erosion. However, at Strahan a most

instructive, if confusing, section is to be seen. The Strahan terraces are well known and their glacial origin is recognized (see David 1924 p. 116 and plate XI). The recently constructed Strahan-Queenstown road has opened up a section which provides remarkable confirmation of Sir Edgeworth's explanation of these terraces and which deserves a brief description.

The road winds out of the Queen River basin (largely post-glacial river topography) on to Howard's Plains and thence a distance of approximately 20 miles across the 'Henty Peneplain' reaching a height of 1100 feet above sea level at a spot just north of Renedeena. Thence it descends to 550 feet at a distance of 3 miles from Strahan. This area is occupied by white brachipod sandstones of the Queen River Series (Silurian) with included grey slates and white to green tuffs and porphyry. These rocks end at a large cutting on the western slope of the peneplain 3 miles from the boundary of the Strahan township and 550 feet above sea level.

From that spot a well preserved glacial moraine is exposed in the numerous road cuttings. This is mostly dark yellow to greyish clay full of grits, pebbles and boulders, numerous ones of which show distinct ice scratches. As far as can be observed in this section the maximum height of this moraine is 600 feet above sea level and it descends on the terraced slopes east of Strahan to 300 feet above sea level. This by no means necessarily records the thickness of the moraine but on the section in question the till is replaced at 300 feet by the Strahan terraces. Its absolute thickness in a vertical section may be much greater but no exposure could be found to indicate this.

The Strahan terraces are at three distinct levels. The top of the highest (more easterly) averages 300 feet. The top of the second, upon which the central portion of Strahan is built and which extends westward to the ocean beach, averages 60-75 feet above sea level. The lower terrace is to be seen as a narrow margin round Macquarie Harbour and rises from 5 to 25 feet above sea level. The moraine mentioned above abuts on the 300 foot terrace and appears to merge into it. The terraces all appear to consist of blown sand, river grit and partly rounded but ill sorted pebbles averaging 2 inches in diameter with a few larger ones. Layers of peat sometimes two feet or more in thickness are included. No consistent arrangement of strata can be observed. The pebble bands vary from a few inches to twenty or more feet in thickness and are distributed without apparent arrangement amongst the sandy accumulations. The arrangement of the whole series bears no relationship to existing topography. Much of the sand is clearly river or fresh water grit. No sign of sea life can be found and aboriginal artifacts are conspicuously absent. The western edge is covered by very recent sand dunes. No distinguishing feature, or in fact any difference other than height, can be identified between the various terraces. Their depth is unknown. They show no traces of varves (see also David 1924 p. 116

for a section of the 60 foot terrace at Strahan railway station which may be taken as typical of the whole series subject to frequent local variations).

In my opinion, the Strahan terraces are all of the same age and are, taken as a whole, contemporaneous with the moraine immediately to the east. At Malanna, the moraine described by Sir Edgeworth David appears to overlie blown sand and pebble deposits undistinguishable from the material of the Strahan terraces. Although no section at Strahan illustrates this so clearly, it appears to me that the same relationship exists at 550 feet 3 miles east of the township. I can find no justification for assuming that the moraine was the product of the earliest glaciation and that the terraces were deposited at lower levels during subsequent glaciations. This is probably the effect produced in river valleys in non-glaciated regions where the terraces lie parallel to the drainage (see Lewis 1935) but such is not the case where the terraces lie at right angles to the direction of the drainage and cover a wide area.

The explanation which appears best to fit all the evidence is that the Strahan terraces were formed from the outwash from melting glaciers or an ice sheet of the Malanna glacial phase. These deposits were laid down originally on a very low and level shore platform or in a wide shallow bay which stretched from Kelly's Basin to Trial Harbour some two to five eastward of the present shore line and perhaps behind a line of sand dunes which may have quite blocked access to the open ocean. In any case the actual floor is not anywhere visible. Some remains of marine life may exist at the level of this floor. A large area was covered with such outwash gravels and blown sea sand was constantly encroaching. Vegetation established itself from time to time but was continually being overwhelmed by newer deposits. There is evidence of very many fluctuations during the deposition with alternations of retreating and readvancing ice, growth and dispersal of sand dunes, accumulation and destruction of peat bogs and forests. There is also evidence that each example of outwash pebble banks, sand dunes and vegetable accumulations were nowhere individually widely distributed and often showed great differences in vertical height with marked erosion effects during the whole period of deposition.

The outwash apron as a whole was widely distributed at first, perhaps further westward than the present coast line. Finally the ice advanced over much of this outwash gravel and actually deposited terminal moraines rising several hundred feet higher. Subsequently to this maximum phase, water flowing from the retreating ice margin assisted to redistribute morainal material in a sharply descending slope to the lower terrace. The present topography is the result of influences ubsequent to the maximum glacial phase—that is to erosion of the moraines and outwash gravels, not entirely to deposition factors.

It is admitted that the absence of sea shell presents a grave objection to any explanation of the formation of these terraces by marine erosion. Sir Edgeworth David also raises the objection that there is no evidence of any terrestrial uplift during the period in question (David 1924 p. 116). However, there is evidence elsewhere of successive rises in the land all over Tasmania (Lewis 1935) and the absence of sea shells may be explained from several causes such as subsequent erosion, or erosion by a virtually fresh water 'inland sea' such as Macquarie Harbour. However, Sir Edgeworth David actually only affirmed that the Strahan terraces were not raised beaches, a conclusion which is now accepted, and my chief point is that the glacial origin recognised by Sir Edgeworth David and proved by the discovery of the moraine immediately to the eastward must be referred to one glacial phase not to three, as may be tempting.

I postulate that the 60 foot terrace and the shore platform at Strahan are referrable to the same positive earth movement as produced the similar features in south eastern Tasmania (Lewis 1935). These are marine erosion features without contemporaneous deposits. The 150 foot terrace noticeable in unglaciated areas is obscured by the higher moraine and outwash gravels.

I also note that the erosion features of the subsequent phases of the Pleistocene glaciation in what I have taken as the type area are to be seen in panorama from the Strahan-Queenstown road near its highest point. The cirque gorge of the Yolande, with the Lake Margaret pipe line, is plainly visible on a clear day. The contour of Lake Margaret is also marked by the pipe line. It is also noticeable that the slope from the top of the Gormanston moraine in the Lyell-Owen Gap to the moraine just east of Strahan represents the natural slope of the western fall of the range prior to the removal of a great portion of the intervening country by the headward erosion of the Queen River.

2. General Correlation

In my previous paper on correlation of glacial epochs, I summarized the arguments advanced in support of a threefold glaciation during Pleistocene times and gave the names Malanna, Yolande and Margaret to the three Tasmanian ice invasions. These ideas worked out well in some localities but I was not very satisfied as to others. Chief amongst the doubtful areas was the Mt. Field plateau where the Margaret ice tarn stage is distinct, and, at 1200-1600 feet lower down the mountain side the remains of the Yolande stage is equally distinct. This Yolande stage is divided into two separate phases showing superimposed cirques, lakes and moraines (See Lewis 1922). However, these two phases are only separated by a vertical interval of 200-400 feet and the time interval did not appear as apparent as in some other

localities (e.g. the type area, Henty Valley). On the other hand, if the lower glaciation on Mt. Field did not represent the Malanna stage, this phase was missing here and the temptation to force a correlation was strong.

Similar doubts as to the glaciation of Mt. La Perouse were resolved by observations recorded in 1935 (Lewis and Murray 1936). We there indicated the possibility of a double phase during the Yolande glaciation. The recent discovery of glaciation in the Florentine Valley now provides the confirmation I sought in 1935. This involves the retraction of the statement in my 1933 paper to the effect that the Yolande stage could not be subdivided, which I now amend to read that the second or later phase of this stage cannot be subdivided.

The sequence as now made clear by a consideration of the cross section of glaciated country from Mt. Field East to the Thumbs is as follows:—The Florentine Valley was at one time filled with ice which descended to at least the 900 foot contour and probably somewhat lower. This ice at its maximum must have filled the valley to a height above the saddles east and west of Tim Shea, that is a thickness of 1200 feet at least. At this time Mt. Field plateau was probably entirely covered by an ice cap which did not leave observable traces on the mountain sides—the glacier forming in the Florentine Valley. It is a distinct possibility also, that the final elevation of the plateau occurred subsequently. In any case stream erosion has been very active on the steep slopes and would be sufficient to remove traces of the ice cap on the eastern and southern sides of the plateau. Two distinct glacial phases occurred during the Yolande stage. In the first, the more intense, ice did not descend the plateau valleys quite to the 2400 foot contour, and in the second, below 3000 feet, giving an average difference in the altitude of the nivation layer in the two phases as about 500 feet. In the quite distinct Margaret stage the nivation layer did not descend lower than 4000 feet (See Griffith Taylor 1922).

We thus can identify in Tasmania four separate ice invasions. Of these, the two middle ones occurred in quick succession, relative to the dates of the preceding Malanna stage and the succeeding Margaret stage. I consider that these two middle glaciations should be regarded as both phases of the one stage. We probably see the effects of a rapid onset reaching its maximum intensity relatively early, then a partial waning followed by a second onset less intense and less sustained than the earlier phase. I therefore prefer to retain the name Yolande for the whole glacial invasion, separating it into a first and a second phase where the evidence is sufficient.

This generalization appears to fit all the field evidence, both of glacial topography and river terraces in non-glaciated areas, which latter do not show definite differentiation between the two phases of the Yolande stage. It is the only explanation which will explain the

topographical details of all the glaciated country when considered as a whole from east to west and it can only be seen when such a section is studied as a whole.

3. Malanna Stage

The remnants of the Malanna glaciation are relatively rare. Mostly, they have been removed by post Malannan river erosion. Through the area under discussion the country consists, in a general way, of plains standing at about 1000 feet above sea level with mountains rising out of them to 3000-5000 feet above sea level. Sometimes the mountains are so closely parallel that the plains become mere valleys. The Malanna stage can be seen on these plains where its features have not been removed by subsequent river erosion or obscured by Yolande glaciers which, where the mountains are high plateaux and the valleys between are narrow, more or less covered the traces of the earlier stage.

The glaciation of the valleys of the Florentine, the Vale of Rasselas, the Huon and Serpentine are attributed to this stage. The same is also the case with Lakes Sorell and Echo and the eastern areas of the central plateau. Any possible glaciation in the Russell Falls and Weld Valleys are likewise referable to this earlier stage. The Surprise Valley is an excellent example of a Malanna cirque and glacial valley. The underlying features of the King River valley and probably of the Franklin and Collingwood Rivers were moulded by Malanna ice flows. The terraces and moraines at Strahan, and the moraines at Malanna are of similar age.

Through the Lake St. Clair valley and thence to the King River there is much morainal material of the Yolande stage strewn over the older glacial valleys along the section traversed by the West Coast road. The Linda moraine is probably a highly eroded fragment of a Malanna moraine. I have already described this feature of outstanding interest (Lewis 1936). It is obviously very ancient and took an immense period to accumulate. I consider that it was deposited in a lake or flat plain. It is clear that this deposition must have taken place when the physiography of the West Coast Range was very different from that presented at the present time. I quite agree with the remarks of Nye and Blake as to the moraines in the neighbouring Sedgwick Gap (Lyell-Comstock) and the relationship of the erosion of the Queen River (Nye and Blake 1938 p. 15). Similar features are apparent in the Linda Gap. Gregory's explanation of glacial features must now be regarded as superseded except as to descriptive detail. Nowhere is the distinction between the Malanna Stage and the succeeding Yolande Stage more pronounced or clearer than in the section from King William Saddle to the Franklin River i.e. the panorama southward from Mt. Arrowsmith. Here the Yolande glaciation of the St. Clair area, extending to the saddle

can be seen at 2400-2800 feet and, below, the old forest covered cirques at the head of the Surprise Valley 1000-1200 feet lower. In the same area the traces of the lesser Margaret stage can be seen in the small cirques high on Mt. King William.

The effect of post Malannan uplift is apparent everywhere. The Gordon and the King Rivers and their tributaries have cut deeply into the glaciated valleys (See David 1924). The waterworn topography round Queenstown is a typical example. This waterworn topography extends eastward up the Gordon Valley to the Great Bend and is very marked round Adamsfield. It is carried up the valleys of all the tributaries of the Gordon for some distance. On the other watershed, the Derwent has cut even more deeply into the glaciated area south of Lake St. Clair, having removed all traces of glaciation below the northern end of Butler's Gorge, where the Tarraleah fluming commences. The Nive, Dee and other south flowing tributaries have cut back to the line of the West Coast road or further and the Florentine has cut into its glacial valley to a point west of Mt. Misery. The Russell Falls and Weld Rivers have almost removed all trace of Malanna stage glaciation from their valleys below about the 1500 foot contour.

It is difficult to fix one elevation as the contour to which more recent river erosion has cut. This varies with each stream. In some cases the present river valley has cut into one side of the older Malanna glacial valley, or cut a sharp trog in the old wider valley, leaving traces of glaciation still surviving. In some valleys the tributaries have removed all trace of Malanna glaciation in other places only one or several tributary valleys have been thus affected, leaving a nearly dry glacial valley at a higher level. For this reason, many apparent contradictions exist. However, it appears clear that during the Malanna stage, ice descended to sea level on the coast and to 900-700 feet at least at the meridian of Mt. Picton-Mt. Field-Lake Echo. During this early stage therefore all the western third of Tasmania, with the southern coast, the central plateau and the north eastern plateau must have been under an ice cap, although it was a Tasmania essentially different in topographical details from what we now know.

4. Yolande Stage

The obvious glaciated features of the uplands belong to this stage. In favourable localities glaciers pushed down valleys to about the 2000 foot contour and developed very fine cirques and comb ridges at their heads. These extend upwards to about the 4000 foot contour, above which ice cap conditions left little mark on the topography. This is the stage responsible for the glaciations of the Mt. Field plateau, Mts. Anne and Mueller, the King William Range, the Eldon Range, and many of the valleys of the West Coast Range including Mts.

Jukes and Tindal. The two phases are frequently in evidence. See particularly Plates XI and XIII in my account of Mt. Field (Lewis 1922). Similar features have been described at Lake St. Clair and Du Cane Ranges (Clemes 1924) and Mt. Jukes (Hills 1914), also at Cradle Mountain (Benson 1917 esp. p. 34) and La Perouse (Lewis 1925). Yolande glaciation is also responsible for many details of the features at the head of the Florentine, Gordon and Surprise Valleys and is the glaciation of the western edge of the central plateau and at the headwaters of the King and Pieman Rivers and their tributaries.

The double phase of the Yolande glacial stage follows over the higher mountains of western Tasmania with sufficient regularity to establish the main features of the stage. The difference in level varies considerably but 400 feet is the average difference and its absence in any particular glaciated locality is to be explained from outside causes, usually the obliteration of the first phase by the second or a sufficiently identical development to cause confusion.

To-day therefore, we have advanced beyond the stage when the existence of glacial features are recorded as an item of interest since we can say positively that all the country west of the 147th Meridian and which is over 1000 feet has been subjected to ice action. Where this is not apparent the explanation is post glacial stream erosion. Moreover, the details of the traces of ice invasions as outlined above are consistent throughout this area varying only with such local features as slope and size of neve catchment.

5. Margaret Stage

This glaciation was the most recent but as the nivation layer at this time did not descend below 4000 feet on the eastern boundary of the area described to 2000 feet on the West Coast Range, only the higher and more westerly mountains were affected. In some areas this glaciation is very distinct (See Griffith Taylor 1922 and Lewis 1922 Plate VIII, Clemes 1925 p. 71, and Plates XI fig. 1 and XIV fig. 1). Pine Lake (Lewis 1933) is referable to this glaciation as are most of the small lakes and other glacial features in the higher levels of the Lake St. Clair-Cradle Mt. National Reserve, and over the western edge of the Central Plateau. Many of the higher lakes on Mt. King William, Denison and Eldon Ranges belong to this stage but without a detailed examination I am not prepared to draw a definite line in these localities between the Margaret and Yolande stages. The glaciation of this stage at the type locality has been well described (Moore 1894, Montgomery 1894).

There is little to add to these descriptions. Cirques with occasional lakes and frequent moraines referable to the Margaret stage lie dotted over our more elevated highlands. The features produced by this glaciation are seen usually on a definite shelf or ledge cut into the

cirque heads of valleys still showing the characteristic features of the Yolande stage. Very often the evidence of the Margaret glaciation is no more than a line of ledges, hollows and miniature cirques round the mountain side at a constant height. In more favoured localities only has this glaciation developed features in any way approaching those of the Yolande stage and then, often, the two stages overlie or merge in a very confusing way. The areas where this glaciation can be established as a distinct stage are those such as Mt. Field, Du Cane Range, La Perouse, and Mt. Anne where the Margaret cirques have distinctly cut into the Yolande cirques. It is often impossible to disentangle the moraines referable to these two stages. However, the evidence of the cirques, ledges and tarns is sufficient to establish the stage as an event quite distinct from both phases of the Yolande glaciation. The best description of the features of this stage were given by T. B. Moore (1894) and Griffith Taylor (1922). Most, if not all of the existing ice scratched pavements are to be referred to this glaciation, a fact which led to much early confusion and I stress again that cirque erosion and not morainal deposits form the only sure guide to differentiate the various stages.

[NOTE.—Since writing the above I have found a reference by T. B. Moore (1896) to glaciation on the Lyell-Strahan road. This was probably an early observation of the moraine now more fully exposed in the road cutting made in 1937 (see *ante* p. 165). Due credit should be given to Moore for his observation under difficult conditions in 1895.]

REFERENCES

BENSON, W. N., 1917.—Notes on the Geology of the Cradle Mountain District. *Pap. Roy. Soc. Tasm.* 1916 (1917) pp. 29-43.

DAVID, T. W. E., 1924.—Geological Evidence of the Antiquity of Man in the Commonwealth. *Pap. Roy. Soc. Tasm.* 1923 (1924) pp. 109-150.

CLEMES, W. H., 1925.—Notes on a Geological Reconnaisance of the Lake St. Clair District. *Pap. Roy. Soc. Tasm.* 1924 (1925) pp. 59-72.

GREGORY, J. W., 1903.—Some features of the Geography of North Western Tasmania. *Proc. Roy. Soc. Vic.* 1903 Vol. XVI Pt. 1.

JOHNSTON, R. M., 1894.—The Glacial Epoch of Australia. *Pap. Roy. Soc. Tasm.* 1893 (1894) pp. 73-134.

HILLS, L., 1914.—The Jukes-Darwin Mining Field. *Geol. Survey Tas. Bull.* 16. 1911 pp. 15-28.

LEWIS, A. N., 1922.—A preliminary sketch of the Glacial Remains in the National Park of Tasmania. *Pap. Roy. Soc. Tasm.* 1921 (1922) pp. 16-36.

————, 1923.—A Further Note on the Topography of Lake Fenton and District. *Pap. Roy. Soc. Tasm.* 1922 (1923) pp. 32-39.

————, 1924.—Notes on a Geological Reconnaisance of Mt. Anne and the Weld River Valley. *Pap. Roy. Soc. Tasm.* 1923 (1924) pp. 9-42.

————, 1925.—Notes on a Geological Reconnaisance of the La Perouse Range. *Pap. Roy. Soc. Tasm.* 1924 (1925) pp. 9-44.

————————, 1933.—Note on the origin of the Great Lake and the other Lakes on the Central Plateau. *Pap. Roy. Soc. Tasm.* 1932 (1933) pp. 15-38.

————————, 1934.—A Correlation of the Tasmanian Pleistocene Glacial Epochs and Deposits. *Pap. Roy. Soc. Tasm.* 1933 (1934) pp. 67-76.

————————, 1935.—A Correlation of the Tasmanian Pleistocene Raised Beaches and River Terraces in Unglaciated Areas. *Pap. Roy. Soc. Tasm.* 1934 (1935) pp. 75-86.

————————, 1936.—A Record of Pleistocene Varied Shales from Tasmania. *The Australian Geographer* 1936. Vol. 11 No. 8 p. 30 and plate facing p. 15.

LEWIS, A. N., and MURRAY, J. F. N., 1936.—Glacial Features in the D'Entrecasteaux Valley. *Pap. Roy. Soc. Tasm.* 1935 (1936) pp. 87-90.

MONTGOMERY, A., 1894.—Glacial Action in Tasmania. *Pap. Roy. Soc. Tasm.* 1893 (1894) pp. 159-169.

MOORE, T. B., 1894.—Discovery of Glaciation in the vicinity of Mt. Tyndall. *Pap. Roy. Soc. of Tasm.* 1893 (1894) pp. 147-149.

————————, 1896.—Notes on Further Proofs of Glaciation at Low Levels. *Pap. Roy. Soc. Tasm.* 1894-95 (1896) p. xxi.

NYE, P. B., 1929.—The Osmiridium Deposits of the Adamsfield District. *Geol. Survey Tas. Bull.* 39. 1929 p. 19 and map.

NYE, P. B., AND BLAKE, F., 1938.—The Geology and Mineral Deposits of Tasmania. *Geol. Survey Tas. Bull.* 44. 1938.

REID, A. M., 1921.—Osmiridium in Tasmania. *Geol. Survey Tas. Bull.* 32. 1921 (*esp.* Plate X).

TAYLOR, GRIFFITH, 1922.—Some Geographical Notes on a Model of the National Park at Mt. Field. *Pap. Roy. Soc. Tasm.* 1921 (1922) pp. 188-198.

TWELVETREES, W. H., 1908.—Report on Great Western Railway Route. Report of Secretary for Lands 1908. Journals and Papers Parliament (Tas.) Vol. LIX Paper 13 p. 25.

The Age and Physiographical Relationships of some Cainozoic Basalts in Central and Eastern Tasmania

By

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(Read 14th November, 1938)

Plates XVII, XVIII

Introduction

The problems associated with the determination of the age of the Cainozoic volcanic rocks of Tasmania are closely analogous to those presented by similar rocks in Victoria. In Tasmania, as in Victoria, certain volcanic rocks are known to be of pre-Lower Miocene age, while others are known to be post-Lower Miocene from their relationships with fossiliferous marine sediments (Nye and Blake, 1938, pp. 50-51).

More generally, however, in both States the lava-flows are associated with Cainozoic sediments of uncertain age, or directly overlie still older rocks. In such circumstances one must turn to physiographical and petrological evidence in any attempt to determine their age. Both these methods have been applied in Victoria recently with considerable success. It was shown that in Victoria while the lava-flows (mainly basaltic) form two distinct petrological suites corresponding to an Older and a Newer Volcanic Series (Edwards, 1938), neither of these series of rocks was confined to a single geological period of time (Hills, 1938), thus confirming previous opinion. The Older

Volcanic Series was shown to range from the Oligocene into the Lower Miocene, while the Newer Volcanic Series ranged from the Middle Pliocene to the Recent.

It seems highly probable that the Tasmanian lava-flows, which are also mainly basaltic, exhibit somewhat similar age relations, which can be investigated by similar means. As a preliminary step in such an investigation, I recently visited and collected from a number of areas of Cainozoic basalt in Central and Eastern Tasmania. This paper records my conclusions with regard to the physiographical evidence of the age of these basalts.

The Time-Scale Terminology

The time-scale terminology used in this paper is as follows:— By *Cainozoic* is meant what is generally termed in Tasmania, Tertiary and Post-Tertiary. By *Pleistocene* is meant the duration of the Glacial Epoch. For North America and Northern Europe, the Pleistocene, so defined, begins with glaciation on a large scale, and is divisible into two parts, the Glacial Epoch and the Post-Glacial Epoch (Daly, 1934, pp. 14-15). The Post-Glacial Epoch covers what is commonly referred to as the *Recent*.

In Tasmania the Pleistocene is divided into three stages, (1) the Malanna or oldest period of glaciation, (2) the Yolande, and (3) the Margaret or youngest stage (Lewis, 1934). Both the Malanna stage and the Malanna-Yolande interglacial period are thought to have been of much longer duration than the Yolande stage, while the Margaret stage was of shorter duration.

Acknowledgements

I have to thank Dr. A. N. Lewis for reading through the manuscript critically, and generously placing at my disposal his considerable knowledge relating to the problems under discussion. Many of his suggestions have been adopted in the paper.

Some General Features of Basaltic Terrains

Before proceeding to the description of the basalts under discussion, it will be as well to summarize certain concepts which apply to basaltic regions generally, and to Victoria and Tasmania in particular.

Lava fields are of two types:—(1) Confined lava fields and (2) extensive lava fields (Keble, 1918). A confined lava field is one which is confined between the pre-basaltic watersheds: an extensive lava field is one where the lavas have overflowed such watersheds. Both types of lava field occur in Tasmania, but all those to be described here are confined lava fields.

Confined Lava Fields

A confined lava field more or less fills the existing valley, deranging the pre-basaltic drainage. In the inauguration of a new drainage system the location of the new stream is guided by the position of the lines of least resistance to erosion, and by the direction of the gradient. These are frequently combined at the edges of the confined lava field, where the lava-flow and the bedrock are in contact. A pair of *lateral streams* develops, one stream on each side of the lava-flow parallel to the original valley, and to one another, and the original lava-filled valley is left in the position of a ridge. The widening of the lateral valleys gradually restricts the residual volcanic rock, and may completely remove it. Generally an *uncovered residual* can be recognized.

It often happens that a confined lava-flow has failed to fill a valley. In such valleys the deranged drainage might form normal lateral streams, but frequently the major part of the water has meandered across the uneven surface of the lava-flow, incising its course upon the lava field. From this a single stream has developed, with minor laterals as tributaries, and tends to divide the basalt into a number of isolated residuals arranged linearly.

If the basalt does not fill the upper part of the original valley, lake conditions will develop upstream from the basalt barrier until such time as the barrier is breached.

Extensive Lava Fields

In extensive lava fields the lava-flows have infilled the pre-existing valleys, and then covered the interfluves between such valleys, so that the pre-basaltic topography is completely obscured beneath wide lava plains. The variations of gradient over the surface of the lava plain decide the course of any new stream, and by the time such a stream has cut down below the surface of the lava its course is impressed upon it. Such streams have a meandering course, and give little indication of their presence from a distance. Impressed meanders and small hanging valleys developed by intermittently flowing tributaries are characteristic of them. They do not develop large tributaries after they have descended below the plain. Such drainage as would form a tributary finds its own path over the plain, and it will be accidental if it should connect with another stream.

If the gradient of the lava plain does not provide any outlet, swamps or shallow lakes will develop as temporary features until they overflow the rims of the natural lava basins.

Local Complications

The widespread occurence in Tasmania of Mesozoic dolerite, which is more or less equally resistant to erosion as are the Cainozoic basalts, introduces complications rarely met with in Victoria, where the bedrock is almost always more susceptible to erosion than the basalts which overlie it.

Thus, other factors being equal, a basalt flow infilling a valley carved in sediments would give rise to physiographic features very different from those produced by a contemporaneous lava flow in a valley eroded in dolerite. Later stream action would erode the sedimentary interfluves much more rapidly than it would the dolerite interfluves, and the lesser resistance to erosion of the sediments as compared with the basalt would give rise to well defined lateral streams, and leave the basalt as an elevated ridge or line of residuals. In the dolerite valley, on the other hand, the erosion would go on more slowly, either along both sides of the lava field as laterals, or as a single stream, and the lava flow would tend to retain its original appearance longer. The basalt filling the sedimentary valley would accordingly assume a deceptive appearance of greater age unless some other feature provided an independent check. An excellent example of this is provided by the basalts of the Interlaken district and those of the Macquarie River, both of which are discussed later. The contrast between them is brought out very clearly in the geological map of the Midlands (Nye, 1921), in which they appear in juxtaposition.

Another effect of this type of difference in the nature of the walls and floor of the original valley would be that lakes formed upstream from the basalt barriers in sedimentary valleys would tend to have a much shorter life than similar lakes formed in dolerite valleys. Still further complications would be introduced where the valley sides changed from dolerite to sediments or *vice versa* along the course of the infilled valley. This also is illustrated by the basalts of the Macquarie River.

A fourth effect is introduced by the shape of the original valley at the time of the basaltic eruption, particularly for dolerite valleys. In a valley with high steep walls, such as the South Esk, the likelihood of the basalt filling the valley to any great height above its floor would be remote, so that there would be little chance of the reconstituted drainage eroding away the original valley walls. On the other hand, where the original valley was broad and shallow, as at the southern end of Great Lake, the level of the basalt might approach the top of the dolerite valley walls. Lateral valleys would be more likely to develop, and the reconstituted streams might be able to erode away the relatively low dolerite interfluves, and leave the basalt as a low ridge.

All these possibilities need to be kept in mind, therefore, during any attempt to assess the age of Tasmanian basalt flows from their physiographical relationships.

Post-Basaltic Faulting

Allowance must also be made for the varying degree of erosion resulting from the post-basaltic faulting which has caused the elevation of the Central Plateau. Streams on the uplifted block have been rejuvenated, and have transformed their valleys into deep gorges. These gorges are deepest near the fault scarp or scarps (Lewis, pers. comm., indicates that the uplift occurred as a series of step faults), and become progressively shallower upstream towards the interior of the Central Plateau. The Nive River basalts provide an example. At Tarraleah a flow of basalt, infilling the pre-basaltic Nive valley, occurs at a height of about 1000 feet above the valley floor of the present Nive River. At Marlborough, about 10 miles further upstream, however, where the basalt again occurs infilling the valley of the pre-basaltic Nive, the present Nive River flows in a narrow gorge-like valley only 100 or so feet deep, and is still vigorously eroding down into the basalt. These two basalt flows are presumably of the same age, but the Marlborough basalt offers the better basis for estimating their age, since it has not undergone such abnormal erosion as the Tarraleah basalt. Other examples are provided by the basalts of the Bashan Plains, which stand at a height of 1000-1500 feet above the floor of the Ouse Gorge, and probably by the basalts of the Interlaken region.

I. Central Plateau Basalts

Areas of basalt occur on the Central Plateau of Tasmania near the southern end of the Great Lake, along the Nive River, near Lake Echo, between the Dee and the Kenmere Rivers, and in the vicinity of Lake Sorell and Lake Cresent at Interlaken. Johnston (1888, pp. 217, 249) regarded these basalts as 'marking the close of the Palaeogene period in Tasmania,' i.e. as Miocene in age, and subsequent workers tended to accept this view (Twelvetrees, 1908). Nye (1921, p. 67; 1924, p. 34) suggested, however, that the Interlaken basalts are either contemporaneous with or somewhat older than the basalts of the Macquarie River, which he considers are probably Pliocene. This view is endorsed by Lewis (1927, p. 22) who considers that 'on the Central Plateau glacial features are superimposed on the newer basalts' and further 'that the Yolande glaciation was more

recent by a considerable space of time than the eruption of the newer basalts' (Lewis, 1934, p. 71). The Malanna glaciation he thinks probably occurred after the extrusion of the basalts, although he is not satisfied on this point. Subsequently he has recognized the possibility that the basalts may have been early Pleistocene extrusions (Lewis, 1935, p. 76). Nye and Blake (1938, p. 26), however, now correlate the Interlaken basalts (their 'high level basalts of the Midlands') with the Oligocene basalts of Marrawah. With this I am unable to agree.

(1) *The Great Lake Basalt*

Basalt outcrops over a considerable area at the southern end of the Great Lake, on both the eastern and western sides. On the western side a ridge of this rock extends as a peninsula for three miles into the lake. Along the northern shore of this peninsula are groups of basaltic cliffs (the Beehives) at intervals. The cliffs are of uniform height, from 25-30 feet above water level. Each group of cliffs consists of about half-a-dozen faces of finely columnar basalt, each face projecting outwards so that the cliff face forms a wavy line 'which when viewed from the water resembles a number of beehives' (Legge, 1904, p. 354). The land at the top of the cliffs is flat for some distance, and then slopes gently down towards the table land which stretches westwards to the Ouse Plains. For some miles back from the cliffs this flat surface is thickly strewn with boulders of basalt.

On the eastern side, 'after being submerged opposite the mouth of the Shannon (the outlet of the Great Lake), it appears again towards Todd's Corner at the Battery, and thence extends southwards over the shoulder of Barren Tier' (Lewis, 1933, p. 24).

The total area covered by this basalt flow or flows is about nine miles from W.N.W. to E.S.E., and about four miles in width. Presumably it fills an old valley which debouched towards the Lagoon. The surface of this basalt area, away from the immediate vicinity of the lake, is distinctly youthful. The original flat surface of the flow is still largely retained over the greater part of it. Moreover, at Liaweene a hill of soft scoriaceous basalt, which may represent a centre of eruption, forms a hill about 100 feet above the level of the plain, and is still as high as a dolerite hill of somewhat similar appearance at the junction of the Miena-Marlborough and Miena-Tingara roads (Lewis, pers. comm.).

Both of these features indicate that the basalt is relatively youthful and but little eroded by subsequent glaciation, a fact appreciated by Lewis, who wrote concerning the basalts of this region generally: 'were it not for the conclusive evidence of surrounding districts, I

would hesitate to say that these basalt plains had been affected by ice' (Lewis, 1933, p. 26). This youthful appearance precludes the likelihood that the basalts are of pre-Malanna age. However, glaciation appears to have occurred after their extrusion, because the surface of the area occupied by the Lagoon, which is 50 or more feet below the level of the adjacent basalt, is covered by moraine material (Lewis, pers. comm.), and glacial erratics occur along the valley of the Shannon, south of the Shannon Outlet (Lewis, 1934, p. 25). This would indicate that the basalts are interglacial in age, presumably post-Malanna and pre-Yolande, and therefore Pleistocene. There remains some possibility that they are pre-Malanna and of Pliocene age, because the Malanna glaciation may not have affected this part of Tasmania. However, they are much less eroded than the basalt flows at Scottsdale, which are regarded as Upper Pliocene or younger (see below). Also, they have undergone much less erosion than basalts in Victoria, which are correlated as Upper Pliocene from their association with marine sediments (Hills, 1938), but this is perhaps an unsafe analogy.

Origin of the Great Lake

Certain considerations with regard to a possible origin of the Great Lake support this conclusion.

Lewis (1933, p. 23 *et seq.*) has shown that glaciation has played some part in the origin of the northern part of the Great Lake, but under no circumstances could it be called a typical glacial lake. Legge (1904, p. 352) has drawn attention to its extraordinary shallowness, and the level nature of its bottom. It has an area of 60 square miles, with an average depth of only 12 feet (prior to the building of the Miena Dam), and with very few places exceeding 20 feet. On the other hand, the valley of the Shannon, south of the dam, 'shows unmistakable evidence of glaciation' (Lewis, 1934, p. 25). This suggests that glacial erosion played some part in developing the whole of the broad valley in which the lake now lies: but there is no indication that it was responsible for the formation of the lake. The outlet through which it debouches into the Shannon River is cut in basalt and dolerite—not in glacial moraines.

It seems probable, in my opinion, that the Great Lake originated as a result of the outpouring of the basalt about Miena. Lewis (1934, p. 25) suggests that 'it is possible that the Great Lake once drained to the Lagoon, *via* Todd's Corner.' Prior to the basalt outflow there was, as indicated, a valley trending more or less in this

direction, into which the broad, shallow valley now occupied by the Great Lake may have drained (assuming that it was formed in pre-basaltic times). As to the origin of this broad valley, no suggestion is offered, but that a correspondingly broad, shallow valley from the north-west joined it at its southern end is clear from the disposition of the basalt.

The outpouring of the basalt lava developed in this north-west valley, probably near Liaweene, and flowed down it, more or less completely filling it, towards the Lagoon. It also probably flowed up the valley now occupied by the Great Lake to some extent, since Legge (1904) describes columnar basalt at water level at Helen's Isle. This may explain the constriction of the lake near this point. The lava flow closed the outlet of the Great Lake valley and dammed back the drainage until it overflowed the basalt and joined the southern lateral stream to the basalt, which is now represented by Swan Bay. Instead of following the course of the pre-basaltic stream to the north of Barren Tier, the dammed up drainage escaped southwards, to the west of it, along the course of the present Shannon River. The outlet of the lake is cut in the dolerite which formed the southern interfluve of the infilled pre-basaltic valley. Presumably the pre-basaltic interfluve was relatively low at this point. That the waters of the lake once extended for a considerable distance over the surface of the basalt prior to the breaching of the dolerite is indicated by the fact that the land at the top of the cliffs at its southern end 'is for miles thickly strewn with basalt stones' (Legge, 1904). The level of the lake must, therefore, have then been at least 30-40 feet higher than it was at the time when the construction of the Miena Dam was commenced. Prior to the building of the dam, it was draining away. The cliffs of basalt along the Beehive Peninsula were probably developed after the breaching of the dolerite outlet. Legge (1904) indicates that the basalt lies on the dolerite almost at water level, and this would render the columnar basalt liable to undercutting, while collapse of the columns would produce cliffs.

Lewis (1933, p. 25) indicates that in the post-basaltic glacial period the whole of the Great Lake valley was filled with an ice sheet. The youthful surface features of the basalt show, however, that the amount of erosion caused by this post-basaltic glaciation was relatively slight and probably added little to the valley structure of the lake. In view of this, the presence of glacial erratics in the Shannon Outlet suggests the possibility that the breaching of the lake had occurred before this period of glaciation developed, rather than that it was brought about by the glaciation. If this is so, the continued existence of the lake confirms the postulate that the basalt flows are relatively young and of Pleistocene age.

Dr. Lewis has wisely counselled caution in accepting this view as to the origin of the lake. He has pointed out (pers. comm.) that a very slight tilting of the Central Plateau block to the north, when it was faulted in post-basaltic times, would have been sufficient to produce the Great Lake. Such a tilt to the north would also have affected the direction of the later consequent streams, and tended to give rise to north-flowing streams or tributaries. More accurate and detailed mapping of the region may establish this, but there is no indication of it on available maps.

(2) *Nive River Basalts*

As indicated above, the valley of the pre-basaltic Nive River is marked by basalt residuals near Tarraleah and at Marlborough. As a result of post-basaltic faulting, and consequent rejuvenation of the river, the Tarraleah basalt now stands at a height of about 1000 feet above the floor of the Nive Gorge. A long spur of dolerite, which divides the Nive from the Derwent, rises for another 200 feet or more on the western side of the basalt, and gives some measures of the pre-basaltic erosion.

About 10 miles upstream is the Marlborough basalt, which extends from the junction of the Pine River with the Nive, down to the confluence of the Clarence River with the Nive. The basalt forms a plain about 10 miles long and about 4 miles wide, with hills of dolerite and Permian limestone on either side. The surface of the plain is distinctly youthful (Pl. xviii, Fig. 2). The Nive now flows in a narrow, gorge-like valley through, and along the edge of, the basalt plain. Being further back from the fault scarp (or scarps), this basalt has undergone much less erosion than the Tarraleah basalt. The valley of the Nive, where the West Coast Road crosses it, is still vigorously cutting down into the basalt. It appears younger than valleys which have been cut in what are presumed to be late Pliocene members of the Newer Volcanic Series of Victoria.

Lewis (1934) has shown that the faulting which affected these basalts was post-Malanna, but pre-Yolande, which fixes the upper limit of age for the basalts as pre-Yolande. The question remains as to whether the basalt is pre- or post-Malanna. The Malanna glaciation extended down to 900 feet above sea-level in the Florentine Valley, immediately south of the junction of the Nive with the Derwent, but the youthful appearance of the Marlborough basalt precludes the possibility of its having suffered intensive glaciation. This suggests that it is post-Malanna, i.e. Pleistocene

in age. There remains the possibility, however, that the Malanna glaciation did not extend to this area, and the youthful appearance of the basalts may indicate merely that they are of late Pliocene age.

The basalt infilling the valley of the pre-basaltic Little Pine River is also probably of the same age, since the pre-basaltic Little Pine River was evidently a tributary of the pre-basaltic Nive.

Such large outflows of basalt must have seriously deranged the existing drainage systems, but it is clear from the continued existence of the pre-basaltic interfluves near Tarraleah and Marlborough, that the pre-basaltic valleys were not completely filled by the lavas. Presumably lake conditions would have developed upstream from the lava flow or flows prior to their being breached; and this may have been a contributive, or at least a predisposing, factor in the development of the Ninety-Nine Lagoon region. Since the basalts did not overflow the original interfluves, the rivers returned more or less to their original positions once the basalt barriers were breached. The later fault movements have rejuvenated them, so that they are now actively cutting deep gorges through the basalts and underlying rocks.

(3) *Lake Echo Basalts*

Basalt flows (the Bashan Plains) cap the ridges between Lake Echo and Waddamana (Lewis, 1933, Pl. xiv). The Bashan basalts stand 1000-1500 feet above the Ouse Gorge, resembling in this respect the Tarraleah basalt. From this it is concluded that the Bashan basalt is of pre-Yolande age. The drainage from this area has reformed as twin lateral streams, the Bashan Plains Rivulet and the Boggy Marsh Rivulet, tributaries of the Ouse. Midway along Boggy Marsh Rivulet, between two areas of basalt, is Martin Cash's Marsh, which presumably owes its origin to the influence of the basalt, indicating that the basalt is relatively young.

Several miles to the south of Lake Echo lies the Dee River basalt, which forms a flat-topped ridge between the Dee and the Kenmere Rivers. These two rivers appear to be lateral streams developed more or less at the edges of the lava flow. The infilled valley, which may be called the 'pre-basaltic Dee' valley, drained much the same country as is now drained by the Dee (and is presumably a continuation of the valley in which Lake Echo now lies. Here, as in the Nive River, the damming back of the drainage must have contributed to the formation of lake conditions, and it is a question whether Lake Echo, which is another of these peculiar shallow lakes, rarely more than 20 feet deep in any part (Lewis, 1934, p. 28), did not once extend as far southwards as the northern end of the Dee basalt.

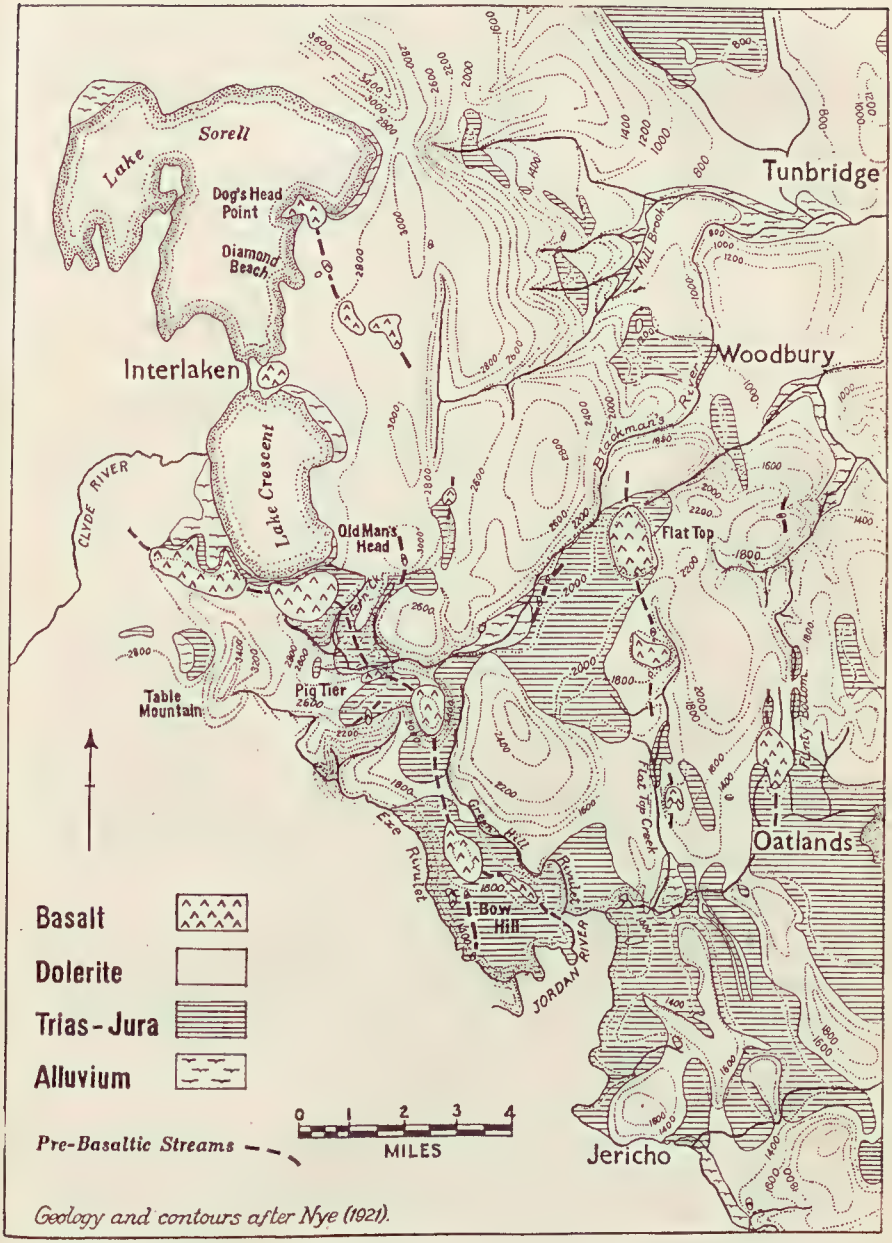

Fig. 1.—Geological Sketch Map showing the distribution of the Interlaken-Jericho basalts and their relation to pre-basaltic stream courses.

Subsequently the basalt barrier was breached by the present Dee River, which, as it cuts vigorously downwards, is causing Lake Echo to recede more and more. Lewis (1934, pp. 27-28) considers that post-basaltic glaciation has contributed to the origin of the Lake Echo valley, so that here again there is evidence that the basalts are probably pre-Yolande. When allowance is made, however, for the fact that they have been subjected to increased erosion as the result of post-basaltic faulting, it seems highly improbable that they could be older than late Pliocene. The continued existence of Martin Cash's Marsh suggests that they are likely to be post-Malanna.

(4) *The Interlaken Basalts*

The basalts in the vicinity of Lake Sorell and Lake Crescent are shown on the geological map of the Midlands (Nye, 1921), on which Text fig. 1 is based. Here again, broad shallow lakes are associated with basalt flows. Lake Sorell is five miles from north to south, and six miles from east to west, and only 13 feet deep in the centre, While Lake Crescent is about 3·5 miles by 2 miles, and only 8 feet deep in the centre (Twelvetrees, 1902, p. 159).

The succession of flat-topped basaltic residuals running south-east from the southern end of Lake Crescent to Bow Hill, each successive residual having its base at a lower elevation, marks the position of a pre-basaltic valley down which the lava flowed. This valley seems to have been a north-westerly continuation of the present Jordan River. The Exe Rivulet has developed as a lateral stream on the south-west side if this lava-filled valley, eroding away the sedimentary interfluve, while the lateral on the north-east side is represented by Fern Creek in the upper reaches, and by Green Hill Rivulet in the lower reaches.

A tributary stream ran due southwards from Flat Top to join this pre-basaltic Jordan, as is shown by the descending level of the bases of the successive basalt residuals in that direction, while another stream flowed southwards from the residual near Flinty Marsh, and a further valley extended from Vincent's Hill *via* Coal Mine Hill towards Andover. Flat Top Creek, Flinty Marsh, Flinty Bottom, and the upper reaches of York Rivulet appear to be lateral streams induced by the filling of these valleys with lava.

It seems probable that the valley now occupied by Lake Crescent and Lake Sorell originally drained into this pre-basaltic river, and the flow of basalt dammed back such drainage, giving rise to, or contributing to, the present lakes. Another stream, now filled with basalt, existed in the vicinity of Dog's Head Point on the eastern shore of Lake Sorell.

A striking feature of the basalt residuals of the pre-basaltic Jordan is that although they are relatively horizontal, considerable differences of elevation exist between successive residuals. For example, there is a difference in elevation of about 800 feet between the base of the residuals near Pig Tier and those at Bow Hills, two miles further 'downstream,' Text Fig. 2. Similarly, the basalt residuals filling the tributaries of the pre-basaltic Jordan are at markedly different elevations. This is well illustrated by Nye (1921, Pl. iii, Sect. EFG).

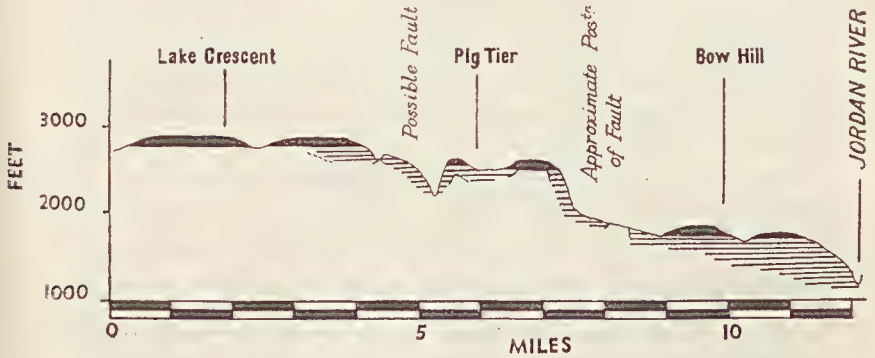

Fig. 2.—Sketch section along the course of the "pre-basaltic Jordan," showing the different levels of the basalt residuals (black).

There can be little doubt, therefore, that the extrusion of the basalts occurred prior to step faulting which uplifted the Central Plateau, despite views to the contrary (Nye, 1921, p. 71). Lewis (1934, p. 20) considers that the valley occupied by the two lakes underwent glaciation during the Pleistocene, so that if the basalts are regarded as responsible for the formation of the lakes, both they and the faulting may be pre-glacial. It seems highly probable that the faulting was more or less contemporaneous with that which affected the basalts further to the west, and that the uplift of the Central Plateau was everywhere pre-Yolande.

The combined effect of the faulting and the infilling of pre-existing valleys by basalt has been to divert much of the drainage into the Clyde River. The waters from Lake Crescent have also found an outlet into the Clyde, round the back of the basalt barrier, and have commenced to drain away. This must have commenced in geologically recent times, because the water level in Lake Sorell is only 2·16 feet higher than that of Lake Crescent (Twelvetrees, 1902, p. 159). The water in Lake Sorell cannot have stood much higher in the past than it does now, because there is no indication that it ever covered the flat-topped basalt residual at Dog's Head Point. This residual now juts out into the lake as a promontory 20-30 feet above

the level of the lake, to which it descends abruptly as a result of wave erosion. The two lakes are connected by a shallow channel through a narrow strip of flat land not more than half a mile wide. The small hill of basalt to the east of this may mark an earlier connection between the valleys these lakes occupy.

The flat surfaces of these basalt residuals, as at Dog's Head Point, a feature upon which Twelvetrees commented (Twelvetrees, 1902, p. 160), suggest that the basalts is relatively youthful. Support for this interpretation might be adduced from Twelvetrees' description of the two small areas of basalt about half a mile east of Diamond Beach (Lake Sorell) as lava cones. Of the smaller he says (1902, p. 165): 'The cone . . . is the most perfect survival of a volcanic cone which I know of in the island. No ash or scoriae are to be seen.' Nye, however, doubts whether they are true cones, and thinks they may be merely residuals.

Reference of these basalts to the Pliocene, or possibly to the Pleistocene, runs strongly counter to the views recently expressed by Nye and Blake (1938, p. 26), but, as indicated in the previous section, I think that the deceptively old appearance of these rocks is due not to their being of great age but to the fact that they were extruded in a region which was relatively susceptible to erosion, and which has developed steep gradients as a result of post-basaltic uplift.

II. The Basalts of the Midlands

Certain small residuals of basalt, properly occurring within the Midlands, have already been described in connection with the Interlaken district. The main areas of basalt in the Midlands are the flows in the valleys of the South Esk and the St. Paul's Rivers, extending from Glen Esk Bridge to above Avoca, and the much larger sheet of basalt stretching more or less along the Macquarie River from Conara Junction to south of Tunbridge. Both of these areas are shown in detail on the geological maps of the Tasmanian Geological Survey (Nye, 1921, 1926), and it will help the reader greatly if he refers to these maps in connection with the ensuing discussion.

Occasional exposures show that the basalts overlie lacustrine or fluviatile Tertiary sediments, both in the valleys of the South Esk and St. Paul's Rivers (Nye, 1926, p. 14) and along the southern bank of the Macquarie River (Nye, 1921, p. 50), to a height of 40 feet above the present stream levels. These sands are considered to represent the southern extension of the beds of the Launceston Tertiary basin, which are correlated as Lower to Middle Pliocene by Edgeworth David (1932, Table I, p. 87) and by Nye and Blake (1938, p. 50), who therefore regard the basalts as Upper Pliocene and possibly contemporaneous with the Newer Volcanic Series of Victoria (Nye, 1921, pp. 67-68).

Age of the Tertiary Leaf Beds

Johnston (1874, 1888, p. 268 *et seq.*) divided the sediments of the Launceston Basin into three zones:—

(1) An unfossiliferous upper zone, consisting of drifts;
(2) A middle zone, containing remains of coniferous trees and *Banksias*, and including the basalt flows;
(3) A lower zone containing remains of *Betula*, *Fagus*, and *Cinnamomum*, as well as other leaves.

It is not clear how well defined these zones are; *Banksia* and *Cinnamomum*, &c., occur together in some localities. This division assumes significance, however, in the light of the recent suggestion (Hills, 1938) 'that *Cinnamomum* and other genera belonging to Deane's "brush" type of flora, not now living in Victoria but found in the warmer and moister parts of Australia, serve to indicate (in Victoria) an Oligocene, Miocene, or possibly Lower Pliocene age,' while '"and open forest" flora, from which the above types are absent but which includes *Eucalyptus*, *Banksia*, and *Casuarina*, and other genera now living in the State, indicates a post-Lower Pliocene age.' If this interpretation applies to Tasmania as well as to Victoria, the sediments of the Launceston Tertiary basin may be regarded as ranging from Miocene or Lower Pliocene, in the lower zone, into a post-Lower Pliocene middle zone, while the upper zone may be Upper Pliocene or even Pleistocene. If this is so, the basalts of the Midlands and the North-East, which overlie sands presumed to belong to the Middle Zone of the Launceston Tertiary Basin, should be either Upper Pliocene in age or possibly Pleistocene.

The leaf beds of the Derwent Basin, on the other hand, appear to be mostly Lower Pliocene or earlier, although Baron von Mueller (1884) indicated that the presence of *Alnus* among the leaves suggests a Pliocene age. The basalts overlying these leaf beds are to be regarded, therefore, as Pliocene or younger.

(1) *Basalts of the South Esk and St. Paul's Rivers Valleys*

The South Esk and St. Paul's Rivers were firmly established before the extrusion of the basalts, and had entrenched themselves in valleys 200-300 feet deep, with steeply sloping walls. The basalt flows, which were 30 or more feet thick (Nye, 1926, p. 14), were confined to the valleys and failed to more than thinly cover their floors. As a result, once the basalt barriers were breached the South Esk and St. Paul's Rivers resumed more or less their pre-basaltic courses, cutting new beds along the northern contact of basalt and dolerite. The high dolerite walls and their resistant character have prevented the development of typical 'lateral' streams, so that the basalts have not been left as high-level ridges as was the case with the Interlaken basalts, whose valley walls in large part consisted of softer sediments.

The basalts successfully dammed back the drainage in these two rivers for a period, giving rise to lakes which slowly spread over the basalts until their waters finally escaped over its surface. Evidence of the existence of these lakes is provided by deposits of loose sands overlying the upper reaches of the basalt flows and at the same level as the basalt downstream from them. These sands are described as 'probably Upper Tertiary' (Nye, 1926, p. 15), because 'the basalt is usually regarded as closing the Lower Tertiary period.' However, the surface features of the basalts are far too youthful for this to be the case. It is unlikely that the basalts would have retained their almost flat surfaces if they had been subjected to the erosion of such vigorous streams as the South Esk and St. Paul's Rivers since even early Pliocene times; and it is still more improbable that the coverings of lacustrine sands in their upper reaches would have persisted under these conditions.

The more recent view that they are Upper Pliocene basalts (Nye and Blake, 1938) fits much better with the appearance of the basalts. The possibility must be considered, however, that they may have been extruded during the Pliestocene. The fact that the lakes formed as a result of their extrusion have been drained, while those of the Interlaken area have not, may indicate that the South Esk basalts are the older of the two: but this is more probably due to their different geological setting, which prevented the dispersion of the pre-basaltic drainage into lateral streams.

(2) *The Macquarie River Basalts*

This sheet of basalt forms a long, narrow plain about 24 miles long, and is about 5 miles broad at its widest point, near Campbell Town, with an average thickness of about 100 feet (Nye, 1926, p. 18). The surface of the plain is generally flat, apart from a few mound-like hills which probably represent some of the original points of extrusion. At its southern end it dies out into isolated residuals.

The basalt has infilled the valley and tributary valleys of a river which was as strongly developed as the pre-basaltic South Esk River, and which I shall call the 'pre-basaltic Macquarie' River. At its southern end it appears to have had two main tributaries, of which the eastern is represented by the basalt residuals of Kitty's Rivulet, and the western by the residuals just east of Tunbridge.

The development of the post-basaltic drainage has been of a different character to that of the South Esk, and this difference has arisen from the difference in rock character of the valley walls of the pre-basaltic Macquarie River. The eastern headwater of the pre-basaltic Macquarie had developed entirely in resistant dolerite, and since the basalt did not fill this valley completely, the drainage soon flowed over the basalt without cutting down the original valley walls, just as in the case of the South Esk River. This gave rise to the present Kitty's Rivulet.

The western headwater, on the other hand, had its valley in much less resistant Trias-Jura sediments. The deranged drainage gave rise to a single 'lateral' (the York Rivulet and the lower part of Blackman's River), which eroded the valley sides in preference to the more resistant basalt, and ultimately left the basalt as a series of elevated residuals.

For a distance of 5 miles north of One Tree Hill (i.e. nearly to Ross), the pre-basaltic Macquarie valley had dolerite for its eastern interfluve, and Trias-Jura sediments for its western interfluve. As a result the western lateral—the York Rivulet and the lower part of Blackman's River—developed a valley below the surface of the basalt, and acquired most of the drainage, including the reconstituted Macquarie River and its tributaries. Still nearer to Ross, however, the sedimentary western wall of the pre-basaltic Macquarie changed to dolerite, with the sediments further to the west. This seems to have deflected the western lateral, now the combined Macquarie River and the Blackman's River, to the west of the old valley course. A further tributary comes to this river across the basalt through another, small sedimentary 'gap' to the north of Ross.

A marked feature of the Macquarie River and the York Rivulet is that alluvial flats extend up their courses from where the Macquarie River crossed the dolerite at the south-western end of Mount Augustus to as far south as Tunbridge on the Blackman's River and the York Rivulet, and Glen Morrison and Kitty's Rivulets on the Macquarie River. The probable explanation of this is that as the Macquarie cut down through the Trias-Jura sediments it became superimposed on this dolerite bar, giving rise to slack water or lake conditions upstream, which in turn caused the deposition of alluvium. This alluvium forms a narrow plain whose surface is about 100 feet below the surface of the basalt.

The Elizabeth River which now flows across the basalt plain just south of Campbell Town to join the Macquarie, was also a tributary of the pre-basaltic Macquarie. Its valley is filled with basalt to a height of 1400 feet at the eastern end, the basalt flow culminating in a small hill which was clearly a point of eruption from which a flow issued and helped give rise to the broad plain north-east of Campbell Town. The new Elizabeth River forms the southern lateral of this flow, while Blanchard's Creek, which reaches the Macquarie *via* Conara Junction, forms the northern lateral. As a result, the basalt flow filling the pre-basaltic Elizabeth River has been elevated to a ridge.

In view of the large amount of river erosion which has gone on since their extrusion, the basalts cannot be very young. Two factors have contributed to the apparent youthfulness of the plain between Conara Junction and Campbell Town, namely, the resistant nature of the valley walls which consist of dolerite, and the deflection of the Macquarie

River to the west of the basalt plain, so that only minor streams have affected it. A more accurate estimate of age may be obtained from the residuals near Tunbridge. These are still flat-topped and relatively youthful in appearance (Pl. xvii, Fig. 3). Physiographically they are to be regarded as not older than Upper Pliocene, which is the age assigned to them by Nye on the assumption that both the pre-basaltic and post-basaltic sands at Conara Junction are related to the upper beds of the Launceston Tertiary Basin. On the other hand, a north-south section across the Elizabeth River, east of Campbell Town, suggests that the basalt north of the river lies in a valley eroded in the pre-basaltic sands, which might indicate a time gap between the deposition of these (?) Upper Pliocene beds and the extrusion of the basalts. There is thus a suggestion that these basalts may be of Pleistocene age.

III. The Coal River and Sorell Basalts

(1) *Coal River Basalt*

A basalt flow extends down the valley of the Coal River from Lowdina, north of Campania as far south as Richmond (Nye, 1922). At Lowdina, where the bedrock consists of Trias-Jura sediments, the flow has been eroded to a series of residuals, but further downstream where the bedrock is dolerite it forms a narrow, flat plain, one to two miles wide, and seven to eight miles long. The flow is about 100 feet thick at the northern end, and dwindles to a thickness of about (?) eight feet at its southern extremity near Richmond. It covered the floor of the Coal River valley, but not to a sufficient depth to derange the drainage. The Coal River overflowed the basalt and cut a new channel along its eastern edge. There is no trace of lacustrine deposits upstream from the basalts, although some must have formed. These being deposited on Trias-Jura sediments, would, like the northern extremity of the basalt, have been exposed to relatively greater erosion than the basalt downstream.

The basalt overlies sands which Nye (1922, p. 37) regarded as Lower Tertiary, and now places in the Lower Pliocene (Nye and Blake, 1938); and it is overlain to the south by gravels and conglomerates which Lewis (1935, p. 81) correlates as pre-Malanna (? Pleistocene). The basalts, therefore, are probably of Upper Pliocene age. The youthful appearance of the flow would suggest that it might be younger and Pleistocene, but this youthful appearance is perhaps deceptive. The eroded state of the northern extremity of the flow probably provides a better basis for estimating the age of the flow.

(2) *Sorell Basalts*

Somewhat more extensive flows, with a Trias-Jura bedrock, occur behind Sorell, and to the west of that township, infilling the valleys of former tributaries to the Coal River. These flows give rise to flats which are distinctly youthful in appearance, and cannot be older than Upper Pliocene and are probably contemporaneous with the basalts of the Coal River.

IV. Basalts of the Derwent Valley

(1) *The Upper Derwent*

Basalts occur in the vicinity if Ouse, Hamilton, and Glenora, and are all of relatively young appearance. The largest flow is at Glenora. It overlies Tertiary sediments which contain leaves of *Fagus* and *Cinnamomum* (Johnston, 1888, p. 289), and are therefore presumed to be Lower Pliocene or older. The basalt has infilled a stream which flowed southwards as a tributary to the pre-basaltic Derwent, and also a part of the Derwent valley. The bedrock in this area consist largely of Trias-Jura sediments, which has enabled lateral streams, the Allendale Rivulet and the Belmont Rivulet, to develop on either side of the basalt-filled tributary. In addition, the Derwent developed as a lateral stream on the north-western side of the flow until it breached it near Gretna, and then continued as a lateral along the south-eastern side of the basalt. Similarly, the Styx River, near its confluence with the Derwent, was turned by the basalt, and now flows along the south-western margin of the basalt, converging towards the Derwent. The basalt remains as a flat-topped ridge with steep slopes to the Derwent and the Styx (Pl. xviii, Fig. 1).

The flow just west of Hamilton infills another south-flowing tributary of the pre-basaltic Derwent. The Clyde River has returned to this original valley, partly on the basalt, and partly along its edge. The Ouse basalt infills the lower reaches of the pre-basaltic Kenmere River. The present Kenmere and the Ouse now form the eastern lateral of this flow.

From their appearance, taken in conjunction with their situation in the path of strong rivers which are still vigorously eroding their valleys, these basalts cannot be older than late Pliocene, and are in all probability Pleistocene in age. Presumably, they are contemporaneous with the uplifted basalts of the Central Plateau.

(2) *The Lower Derwent*

Opinions as to the age of the basalts of the Lower Derwent have varied considerably. Johnston (1888) regarded them as Miocene; Allport (1875, 1877) thought them to be Pleistocene, but revised

this opinion to Pliocene when they were found to underlie and not overlie the Geilston travertine beds; Noetling (1914) considered them to be Pleistocene, though on somewhat unsound evidence. They are now regarded as Upper Pliocene (Nye and Blake, 1938), although Lewis (1935) has recognized the possibility that they may be Lower Pleistocene.

At several localities they overlie beds containing the *Cinnamomum* flora (e.g. at Geilston, One Tree Point, &c.), while near New Norfolk and Bridgewater they are overlain by gravels which Lewis (1934) correlated as 'immediately pre-Malanna.' This would have established their age definitely as Upper Pliocene, but actually 'the real pre-Malanna gravels at Old Beach, Millbrook Rise, and elsewhere do not overlie the basalts' (Lewis, pers. comm.), so that the basalts may possibly be Pleistocene.

The most extensive of these basalt flows is that stretching from Pontville to Bridgewater. This has been mapped by Nye (1922). It filled the pre-basaltic valley of the Jordan River from its confluence with the Derwent to its original junction with the Bagdad and Strathallern Rivulets, the valley of a tributary which previously flowed eastwards along a dolerite-sediment contact to this point, and the lower reaches of the Bagdad and Strathallern Rivulets. These streams were all ponded until they overflowed and breached the basalt, and it is a question whether the alluvial deposits occuring upstream may not have originated partly in this way. Except in the case of the Jordan River, the valleys of these creeks across the basalt are still narrower than their valleys upstream, so that alluvium may be still depositing. The stronger Jordan River, however, has cut a sufficiently wide valley in the basalt for it to cease depositing alluvium upstream, and appears to be eroding previously deposited alluvium. There is here a suggestion of youthfulness that confirms the youthful appearance of the basalt surface, and supports Lewis's earlier suggestion that these basalts 'may not date further back than the opening of the Pleistocene period' (Lewis, 1935, p. 76).

The basalts outcrops downstream from Bridgewater are presumably of a comparable age. Dr. Lewis has suggested to me that they may be part of one extensive flow (or flows) that continued down the valley of the Derwent from Bridgewater, but are now dissected and submerged beneath the waters of the estuary.

The ridge of basalt extending from Rokeby to Droughty Point probably infills an elevated tributary of this pre-basaltic Derwent. In some occurrences in the Hobart district, however, the basalt has undergone elevation by faulting of uncertain age, and occurs as isolated residuals, as in the vicinity of Cambridge, Kingston, and Margate, and on the summit of Mt. Wellington. The age of these residuals will remain uncertain until the extent and age of the faulting

has been ascertained. In close association with these faulted residuals now standing at various elevations are further residuals at sea-level which appear to be of comparable age to the Pontville-Bridgewater basalts.

V. Some North-Eastern Basalts

Observations of the basalts in this part of Tasmania were limited to the flows along St. Patrick's River, at Scottsdale, along the Ringarooma River, and at Weldborough Pass.

(1) *Weldborough Pass*

As indicated by Nye and Blake (1938, p. 26), the small area of basalt outcropping at the top of Weldborough Pass is much older than the other basalt flows of this region, with the probable exception of a small residual of high-level basalt at Bulman Bluff, near Branxholm (Nye, 1925, p. 21). The basalt at Weldborough Pass originally filled a valley in the granite, of Blue Tier, and is presumably a remnant of an old land surface which was eroded away prior to the development of the Launceston Tertiary Basin, so that the basalt is of Miocene or possibly earlier age.

(2) *Basalts of the Ringarooma Valley*

These basalts, on the other hand, are relatively young. Nye and Blake (1938) regard them as post-Miocene and probably Upper Pliocene. Edgeworth David (1932, Table I, p. 87) places them as Werrikooian, since they overlie sands which contain fossil fruits and wood, and are therefore correlated with the sediments of the Launceston Tertiary Basin (presumably the Middle or Upper Zone). The basalt has been mapped in detail by Nye (1925). In the southern part of the area the basalt did not completely fill the pre-basaltic Ringarooma valley. This is shown in a photograph (Pl. xvii, Fig. 1) taken looking south from near the fork of the Branxholm-Ledgerwood and Branxholm-Launceston roads. The youthful, flat surface of the basalt can be seen running back to hills of granite and Lower Palaeozoic sediments in the right middleground. The northward profile of the basalt is equally youthful (Pl. xvii, Fig. 2). North of Branxholm a greater number of flows was extruded, and these seem to have completely filled and somewhat overflowed the pre-basaltic valley. As a result, the post-basaltic Ringarooma River, which established itself on the basalt in the southern part of the area, became the eastern lateral in the northern part, and eroded down the granitic interfluve of the pre-basaltic valley.

The relations of the base of the basalt to the contours on Nye's geological map indicate that the surface of the pre-basaltic sands was more or less flat with a gentle, northerly slope, and that the

streams had cut valleys about 50 or more feet deep in these sands, indicating that the estuarine conditions had passed away before the extrusion of the basalts.

Downstream from Herrick it seems probable that the pre-basaltic Tertiary sands completely filled the existing valleys, and even may have covered the interfluves between them. Once the Ringarooma River was established on the eastern margin of the basalt with the bedrock, it probably tended to continue in this position further downstream, getting below the level of the surface of the sands until it became superimposed on the underlying granite well to the east of its pre-basaltic course. The Boobyalla River also seems to have developed as a 'lateral' to the Tertiary sands.

(3) *Scottsdale Basalts*

The large area of basalt in the vicinity of Scottsdale overlies granites and Tertiary gravels in a valley excavated in the granite. The basalt has been considerably eroded, so that it now caps a series of radiating ridges in the floor of the older valley. It appears to be older than the Ringarooma basalts, but this may be due to the fact that the valley in which it lies has always been at a higher level than the Ringarooma valley, since it escaped sedimentation during Lower-Middle Pliocene times. The gravels underlying the basalt are presumably to be correlated with this period, while the basalt is probably Upper Pliocene in age. The pre-basaltic drainage has been dispersed and replaced by the Cox Rivulet and Muddy Creek.

(4) *St. Patrick's River Basalt*

The extent and shape of the St. Patrick's River basalt is shown in a sketch map accompanying the report on the Lisle Goldfield (Twelvetrees, 1908). The youthful appearance of the basalts indicates that they belong to the Upper Pliocene-Pleistocene series of basaltic eruptions, but insufficient time was spent in the area more than to suggest possible explanation of the various physiographic problems associated with these flows.

The basalt has filled the valley of a pre-basaltic stream which flowed southwards from Myrtle Bank, and was, like the St. Patrick's River, a tributary of the North Esk, but joined it much further to the north than does the St Patrick's River. In its lower reaches this pre-basaltic river followed the same course as the Distillery Creek. The more northerly part of the lava flow filled a valley in the Cambro-Ordovician sediments, and the deranged drainage developed as lateral streams, the Patersonia Rivulet and the St. Patrick's River, which have cut down into the bedrock and left the basalt more or less as an elevated ridge. Proceeding downstream, however, the bedrock changes to dolerite, and this deflected the Patersonia Rivulet across the surface of the basalt, causing it to combine with the St. Patrick's River.

Under normal conditions one would expect the St. Patrick's River to continue along the basalt-filled valley, as e.g. the South Esk River does, and Twelvetrees' map suggests that it formerly did so, along what is now Distillery Creek. Some abnormal factor must have intervened to turn the St. Patrick's River southwards across the dolerite wall of the pre-basaltic valley. It is to be noticed that the St. Patrick's River follows a relatively straight course from the place where it leaves the pre-basaltic valley to its present junction with the North Esk River, and it appeared to me, from my very brief observations, that the country immediately east of the St. Patrick's River was at a lower elevation than the country to the west. These two observations lead me to think that either (1) the St. Patrick's River may have been deflected from its former course down the pre-basaltic valley by a post-basaltic fault, or (2) that the bedrock east of the river is composed of sediments and not dolerite, as shown on the Geological Map of Tasmania. Twelvetrees' map is not complete at this point, but he shows a dolerite boundary on the western side of the river.

Another unsolved problem is presented by the right-angled bend in the St. Patrick's River near Myrtle Bank. This may simply be a lateral stream, but the alignment of the basalt residuals in this vicinity, shown in Twelvetrees' map suggests the possibility that there may have been a pre-basaltic stream here which flowed to the north, and formed the headwaters of the pre-basaltic Little Foresters Rivulet. If this were so, the upper part of St. Patrick's Creek was turned southwards by the basaltic barrier.

Summary of Conclusions

Study of the physiographic relationships of some Cainozoic basalts of Central and Eastern Tasmania shows that most of these extrusions were confined within pre-existing valleys, and frequently failed to fill the valleys, much less to cover their interfluves. This was particularly so when the pre-basaltic valleys were deep and narrow. The nature of the bedrock has considerably influenced the rate and effects of the post-basaltic erosion. Where the bedrock consisted of sediments, lateral streams have frequently developed, and the basalt has become an elevated ridge or series or residuals. Where the bedrock consisted of resistant dolerite, the post-basaltic drainage has tended to return more or less to its pre-basaltic course, and has not been able to erode away the interfluves to the same degree. As a result, a basalt flow with a sedimentary bedrock may have developed a misleading semblance of greater age in comparison with a basalt flow of similar age on a dolerite bedrock. Further complications are introduced where the character of the bedrock varies along the course of the lava flow, and where post-basaltic faulting has caused rejuvenation of the rivers.

Of the basalts examined, all but one are relatively young extrusions, ranging in age from Upper Pliocene to Middle Pleistocene. The lavas whose age is most readily gauged are those of the Central Plateau, where the basalt flows are associated with distinctive shallow lakes, which may owe their origin, at least in part, to the basalt flows. These basalts have undergone pre-Yolande faulting, so that they cannot be younger than Middle Pleistocene; their youthful features indicate that they cannot be older than late Pliocene, and there is some suggestion that they are post-Malanna.

In the Derwent valley equally youthful-looking basalts overlie Tertiary beds containing the *Cinnamomum* flora, and are overlain by gravels which may be pre-Malanna or younger. Recent studies have indicated that in Victoria the *Cinnamomum* flora may range from Oligocene to Lower Pliocene. The upward gradation of this flora in the Launceston Tertiary Basin to a flora tentatively regarded as post-Lower Pliocene in Victoria may indicate that the basalts in the Midlands, which overlie the Launceston Tertiary beds, are not older than Upper Pliocene. The degree of preservation of the basalt surface suggests that they may be still younger.

Of the north-eastern areas examined, little can be added to the conclusions of previous workers. The youthful appearance of the basalt surfaces suggests that they are of Upper Pliocene to Pleistocene age. The basalt at Scottsdale appears to be somewhat older than that at Ringarooma and Branxholm, and if the Scottsdale basalt is regarded as Upper Pliocene, the Ringarooma basalts may well be Pleistocene. It seems probable that intermittent extrusions occurred in different parts of the State throughout Upper Pliocene and Pleistocene times.

Only one area of basalt among those examined, that at the top of Weldborough Pass, appears to be older than Upper Pliocene. This basalt, like the high-level basalt at Bulman's Bluff near Branxholm, is a residual from a pre-Pliocene landscape, so that it is of Miocene or earlier age and may tentatively be correlated with the pre-Lower Miocene basalts of North-Western Tasmania. The high-level basalts of the Midlands, on the other hand, have been shown to belong not to this early period, as has been suggested, but to the (?) Pleistocene extrusions of the Central Plateau. The apparent age of these basalts is the outcome of the special susceptibility of their environment to erosion.

References

Allport, M., 1875.—*Pap. Roy. Soc. Tas.*, 1874 (1875), p. 30.

————, 1877.—*Ibid.*, 1876 (1877), p. 60.

Daly, R. A., 1934.—*The Changing World of the Ice Age*; Yale University Press.

David, T. W. Edgeworth, 1932.—*Explanatory Notes to the Map of Australia.*

Edwards, A. B., 1938.—The Petrology of the Tertiary Older Volcanic Rocks of Victoria; *Proc. Roy. Soc. Vic.*, n.s., li (1).

HILLS, E. S., 1938.—The Age and Physiographical Relationships of the Cainozoic Volcanic Rocks of Victoria; *Proc. Roy. Soc. Vic.*, n.s., li (1).

JOHNSTON, R. M., 1874.—Regarding the Composition and Extent of certain Tertiary Beds in and around Launceston; *Pap. Roy. Soc. Tas.*, 1873 (1874), pp. 39-47.

————————, 1888.—*The Geology of Tasmania.*

LEGGE, W. V., 1904.—A Physiographical Account of the Great Lake; *Proc. A.A.A.S., Dunedin*, vol. x.

LEWIS, A. N., 1927.—Note on the Isostatic Background of Tasmanian Physiography; *Pap. Roy. Soc. Tas.*, 1926 (1927).

————————, 1933.—Note on the Origin of the Great Lake and other Lakes of the Central Plateau; *Ibid.*, 1932 (1933), pp. 15-38.

————————, 1934.—A Correlation of the Tasmanian Pleistocene Glacial Epochs and Deposits; *Ibid.*, 1933 (1934), pp. 67-76.

————————, 1935.—Correlation of the Tasmanian Pleistocene Raised Beaches and River Terraces; *Ibid.*, 1934 (1935), pp. 75-86.

MUELLER, BARON F. VON, 1885.—*Ibid.*, 1884 (1885), pp. 206-7.

NOETLING, F., 1914.—*Ibid.*, 1913 (1914), pp. 95-110.

NYE, P. B., 1921.—Underground Water Resources of the Midlands; *Geol. Surv. Tas., Underground Water Supply Paper* No. 1.

————————, 1922.—Underground Water Resources of the Jericho-Richmond-Bridgewater Area; *Geol. Surv. Tas., Underground Water Supply Paper* No. 2.

————————, 1924.—Underground Water Resources of the Richmond-Bridgewater-Sandford District; *Geol. Surv. Tas., Underground Water Supply Paper* No. 3.

————————, 1925.—The Sub-basaltic Tin Deposits of the Ringarooma Valley; *Geol. Surv. Tas.*, Bull. 35.

————————, 1926.—Underground Water Resources of the St. Mary's-Conara Junction Area; *Geol. Surv. Tas., Underground Water Supply Paper* No. 4.

NYE, P. B., and J. BLAKE, 1938.—The Geology and Mineral Deposits of Tasmania; *Geol. Surv. Tas.*, Bull. 44.

TWELVETREES. W. H., 1902.—Report on the Geology of the East Shore of Lake Sorell; *Rept. Sec. for Mines, Tas.*, p. 159.

————————————, 1908.—Outline of the Geology of Tasmania; *Rept. Sec. for Mines, Tas.*

————————————, 1908.—The Lisle Goldfield; *Geol. Surv. Tas.*, Bull. No. 4.

PLATE XVII

FIG. 1.—Branxholm: Basalt-filled valley, looking south from near the fork of the Branxholm-Ledgerwood and Branxholm-Launceston roads. The youthful, flat surface of the basalt can be seen running back to hills of granite and Lower Palaeozoic sediments in the right middleground.

FIG. 2.—Branxholm: The northward profile of the basalt is equally youthful. (Same locality as Fig. 1.)

FIG. 3.—Tunbridge: Showing the youthful profile of the basalt residuals east of Tunbridge outlined against dolerite hills in the background.

Fig. 1.

Fig. 2.

Fig. 3.

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The Soils and General Ecology of the North-East Coastal Regions of Tasmania

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Plate XIX

(Read 14th November, 1938)

Recently an examination of the north-east coastal zone of Tasmania was made by means of some fourteen traverses across the area. These traverses were made following a detailed investigation of the soils and vegetation of approximately 7500 acres at Curries River and Stony Head some six to nine miles from Lefroy. This survey was undertaken at the request of the Department of Agriculture of Tasmania prior to a projected scheme of land development, and the extension of the investigation reported here was carried out for the purpose of determining the area and distribution of similar country in the north-east, to find to what extent the Curries River area is typical of the whole, and to assess generally the agricultural possibilities of the coastal strip.

Topographically the north-east coast, which embraces the coastal lands from the mouth of the River Tamar to George Bay on the east coast, presents a simple arrangement of features frequently associated with relatively low coastlines, namely, a belt of dunes fringing the sea shore, a well-marked trough behind the dunes, with the usual swamps and lagoons therein, and then more or less

gradually rising country intermediate between the coastal features and the more hilly and mountainous areas farther inland. Apart from Mt. Cameron, White Rock Tier, Ringarooma Tier and Mt. William, and certain rocky bluffs and capes on the coastline there are few prominent features of any great topographical significance in the coastal belt or adjoining rising country.

Superimposed upon the above simple topographical arrangement is an equally simple arrangement of soils and vegetation. This is shown on the accompanying sketch map where the dunes, the dune trough, and the gently rising country occupy the zone marked as *heath plain with coastal dunes*. Farther inland from this and occupying slightly hilly to hilly country is a zone of *sclerophyll forests and scrubs*, and still farther inland occupying the more hilly and mountainous areas a zone of *wet sclerophyll and rain forests*. It is with the first two zones that this investigation is concerned.

Vegetation Zones, North-East Coast of Tasmania.

In the first zone the dunes and adjacent lagoons and swamps are of recent origin whereas the intermediate rising plain country consists of pleistocene and pliocene sands with some swamps and heavy soil flats. Farther inland, occupying the second zone and with some outcrops in the coastal area, are cambro-ordivician slates and schists, granite, and dolerite and basalt as intrusives. The granite is more common in the eastern half of the area.

The sand dunes of the coastline vary, in their unbroken state, up to fifteen chains wide. Often they are considerably broken, the landward edge of the dunes being quite serrated, the direction of the

teeth being away from the prevailing westerly wind. Frequently the sand reaches much farther than a mile inland. Where the dune sand has been completely blown away there is often exposed old soil profiles and hardpans in various stages of destruction. These are apparently the remains of the soil type profile now characteristic of the heath plain country. The soil profile of the consolidated dunes consists of a very variable depth of sand with organic matter accumulation over deep yellow calcareous sand. Frequently old surface horizons are encountered in the profile. Plate XIX, fig. 1, shows partially broken dune with the trough beyond.

On the seaward side the dunes have a low cover of *Spinifex hirsutus, Juncus maritimus, Poa caespitosa, Acena sanguisorba, Heleocharis acuta,* with a little *Danthonia* and occasionally other grasses. There are isolated windswept specimens of *Leucopogon richei, Bursaria spinosa,* and *Cassineia aculeata.* On the sheltered side the vegetation is of much larger habit and denser growth, the chief species, apart from those listed above, being *Acacia sophorae, Banksia marginata,* and *Pteris aquilina,* with very occasional specimens of *Eucalyptus viminalis, E. amygdalina, Leptospermum* spp. and a number of species of the Restiaceae.

The soils of the coastal trough vary from true deep peaty swamps to deep wet sands with variable accumulation of organic matter. Elongated sheets of water are frequent and the vegetation varies considerably. It is, however, significantly the most naturally grassy area in the coastal zone, the two commonest species being *Themeda forskalii* and *Danthonia penicillata.* Other common species listed were *Xerotes* spp., *Lepidosperma elatior Diplarrhena Moraea,* and many species of the Restiaceae and Juncaceae. *Acaena sanguisorba, Hibbertia angustifolia* and *Pimelea glauca* were more restricted in their distribution, with a few localities in which the latter was dominant or nearly so.

The gently rising land intermediate between the above features and the inland soils occupies the greatest portion of the coastal zone, and it was primarily to estimate the possibilities of this area that this study was undertaken. The greater part of this gently sloping country is occupied by a humus podsol soil type which is distinguished by an acid reaction, and waterlogging in the wetter months of the year. The soil profile consists of about one foot of dark grey sand with accumulation of coarse organic matter over a depth of light grey sand, beneath which, and commencing at about 30 inches lies a black and brown organic hardpan frequently more than a foot thick. Beneath the pan lies a considerable depth of light grey sand. Analytical data for this soil type are included in the table given as an appendix to this paper.

This soil type represents one of the poorest phases of podsolic soil developed in Tasmania and is characterized by a dominant heath vege-

tation (Plate XIX, fig. 2) whose principal components are a large number of species of the Epacridaceae, the genera of most frequent occurrence being *Epacris* and *Leucopogon*.

There is also present a large number of smaller plants belonging to the order Leguminosae, the commonest being *Gompholobium huegelii* and *Kennedya prostrata*. The species of larger habit are represented by *Leptospermum scoparium*, *Melaleuca squarrosa*, *M. gibbosa*, *Acacia verticillata*, *Xanthorrhaea australis*, *Banksia marginata*, very stunted *Casuarina distyla*, and *Eucalyptus amygdalina*. Of occasional occurence is *Xerotes longifolia*. The presence and habit of the Eucalypt seemed to be determined by the degree of shelter from the wind. In clearly windswept localities it was totally absent, in slightly sheltered situations it was stunted and bent over at considerable angles, and in generally sheltered situations it attained its normal development. All three phases were noted on the humus podsol soil type.

Also in the zone of the humus podsol occur limited areas of three soil types related to the humus podsol and a limited acreage of heavy soil flats with variable profile. Analytical data on a profile from two of the sub-types typified by a marked dominance of *Xerotes longifolia* and by *Pimelea glauca* and on a profile from a heavy flat are contained in the table at the end.

In the sclerophyll forest and scrub zone the soils are more normally developed podsols residual on the rocks of their origin. There is some variation in the texture of the surface soil from sand to silty loam similar to that exhibited by such soils elsewhere in Tasmania. The subsoil consists of yellow and grey mottled clay. In the soils derived from granite there is a marked presence of grit throughout the profile. Other minor variations noted were the presence of a small quantity of ironstone gravel in the subsurface horizons and occasionally a slight induration of the same horizon.

The vegetation on these soils, illustrated in Plate XIX, fig. 3, consists principally of a sclerophyll forest of *Eucalyptus viminalis* and *E. amygdalina* with *E. sieberiana* on the gritty soils derived from granite. Other large species of common occurrence are *Acacia* spp., *Casuarina* spp., *Exocarpus cupressiformis*, *Banksia marginata*, *Leptospermum* spp. and *Melaleuca* spp., with an underscrub of numerous species which varied considerably with such conditions as soil drainage, topography and profile differences. The chief vegetation classes developed were the dominance of heath on very sandy soils, the dominance of *Xerotes* and grasses on the sandy loams and silty loams where the drainage was good, and the development of scrubs of *Leptospermum* and *Melaleuca* where the drainage was poor.

The zone occupied by the heath plain and coastal dunes is at present utilized for grazing sheep, the carrying capacity varying from 10 to 20 acres for one sheep. Owing to their ready destruction

and consequent blowing the dunes should be excluded from any plan of utilization. The swamps of the dune trough and the heavy flats are obvious sites for development but, though numerous, they aggregate only a small percentage of the total area. Similarly, the better phases of the heath plain characterized by a less heathy vegetation are possible of development with subterranean clover but they represent only a small percentage of the area occupied by the humus podsol. The normal and extensive phase of this soil, although carrying only a light and therefore easily cleared vegetation, is a very poor soil and except for the Naracoopa sand* of King Island no pastures of any value have been seen on similar soils elsewhere in the State. On the Naracoopa sand, which is a slightly better soil with a dominant braken vegetation, subterranean clover pastures take about six years to rise to full production. The sclerophyll forest and scrub area is characterized by soils which are growing good subterranean clover pastures in numerous localities elsewhere in the State.

* Stephens, C. G., and Hosking, J. S. A Soil Survey of King Island. *C.S.I.R. Bull.* No. 70.

APPENDIX

Soil and Vegetation Type.	Heath Plain with Humus Podsols.														Heavy Flat Soil.		Sclerophyll Forest Podsol.					
	Normal Type.					Sub Type 1.					Sub Type 2.											
Soil Number	5412	5413	5414	5415	5416	5417	5418	5419	5420	5421	5432	5433	5434	5435	5436	5437	5438	5426	5427	5428	5429	5430	5431
Horizon	A1	A2	A3	B1	B2	A1	A2	A3	B1	B2	A1	A2	B1	B2	B3	A1	A2	A1	A2	B1	B2	B3	B4
Depth in Inches	0-5	5-11	11-24	24-27	27-36	0-9	9-21	21-38	38-48	48-69	0-4	4-19	19-22	22-23	33-48	0-2	2-11	0-1	1-4	4-8	8-11	11-24	24-36
Per Cent.																							
Coarse Sand	56.0	64.3	62.0	60.9	55.2	47.0	54.1	51.6	51.9	58.0	52.0	64.0	59.7	41.2	43.8	4.3	11.7	19.7	26.7	29.0	23.5	15.4	16.8
Fine Sand	32.1	31.6	35.2	24.7	29.6	45.0	39.2	42.7	38.6	36.3	33.7	27.7	18.3	15.6	14.5	12.7	22.7	43.5	47.9	47.3	42.5	26.3	28.5
Silt	3.6	1.7	1.3	6.4	2.5	3.2	2.6	3.1	2.4	1.7	6.0	5.2	14.1	5.3	5.7	21.0	14.3	15.5	17.7	20.1	21.6	14.3	16.3
Clay	2.4	3.3	1.4	5.4	8.8	2.8	2.8	2.4	5.6	3.7	3.7	2.1	7.8	34.6	33.1	31.3	39.9	5.3	3.2	3.2	12.4	41.2	37.2
Loss on Acid Treatment	0.3	0.0	0.0	1.2	1.5	0.6	0.3	0.2	0.7	0.3	0.5	0.1	0.2	0.8	0.9	2.3	1.8	0.9	0.4	0.2	0.7	0.8	0.7
Moisture	1.1	0.2	0.1	0.7	1.9	0.6	0.3	0.2	0.7	0.4	0.7	0.1	0.6	3.6	3.7	7.2	4.6	2.5	0.9	0.3	0.3	2.3	1.8
Loss on Ignition	5.9	1.4	0.5	2.2	3.2	2.4	1.1	0.6	1.9	1.0	3.6	0.4	0.2	3.9	2.5	22.0	10.1	14.7	5.1	1.0	1.0	5.4	4.2
% P_2O_5 Hydrochloric	0.007	—	0.002	—	—	0.014	—	—	—	—	0.010	—	—	0.003	—	0.057	0.017	0.025	0.010	—	—	—	—
% K_2O Acid Extract	0.033	—	0.028	—	—	0.018	—	—	—	—	0.388	—	—	0.219	—	0.438	0.498	0.103	0.072	—	—	—	—
Reaction pH	5.7	5.4	5.8	5.3	5.2	8.2	7.9	7.8	7.6	7.2	6.3	6.5	6.9	7.0	6.8	6.5	7.0	5.6	5.1	5.7	5.8	6.3	7.7

PLATE XIX

FIG. 1.—Partially broken dune with lagoon trough beyond

FIG. 2.—Typical vegetation on humus podsol soil type.

FIG. 3.—Typical sclerophyll forest on normal podsol.

Fig. 1.

Fig. 2.

Fig. 3.

NATIONAL MUSEUM OF VICTORIA

Notes on the Habits of the Extinct Tasmanian Race

No. 4:—On the Discovery of Tasmanian Aboriginal Remains at Mt. Dromedary, Tasmania

By

W. E. L. H. Crowther

(Read 14th November, 1938.)

In September, 1938, a small group of human bones was discovered by N. Johnson, whilst looking for birds' nests in a sandstone cliff, at Mt. Dromedary. An incomplete cranium, forwarded to the Tasmanian Museum was recognized as being almost certainly that of a Tasmanian aboriginal.

A police inquiry being necessary, a visit was made to the locality by the writer, accompanied by Dr. Pearson and Mr. Whittle of the Police Department.

On the northern face of Mt. Dromedary is a deep valley running downwards in a north-west direction towards the Back River. Here, at an elevation of 1475 feet, is a bold sandstone scarp in the face of which is a series of sandstone shelters known locally as Martin Cash's Caves. Cash, the well-known bushranger, hid for a time in this area about 1840, and it is possible that he and his gang actually occupied these shelters.

At the site where the bones were found, the scarp slightly overhangs the base, and there are several recesses, which, although not actually caves, give shelter from all weather except from the north-west and north. The sandstone itself is soft and deeply fretted in places, resembling lace-work, and there is a general tendency for the stone to weather rapidly. The bones were found in a shallow recess about 12 feet above the base of the scarp.

The recess was little more than a shelf, about 6 feet each way and inclined downward and forward. At the time of our visit the human bones had been removed to ground level, but scattered in cracks and inequalities of the shelter were remains of birds and small marsupials principally the ring-tailed opossum.

There was no evidence that the human remains had been wrapped or preserved.

Description of the Bones

The bones were as follows:—

(1) The facial portion of the cranium.
(2) The right *os innominatum* (incomplete).
(3) The left *os innominatum* (incomplete).
(4) Two pieces of the left femur.

The Cranium

This comprised the facial portion consisting of the frontal bone, right and left malars and maxillae, all in excellent preservation. The orbital areas showed the Tasmanian characters being low and quadrilateral in shape. These were not, however, as marked as in a fully developed skull, nor did the superior margin project beyond the lower.

The dentition was not complete, and many of the teeth were missing. The 1st molar (right) and 2nd pre-molar (left) had been broken at the alveolar margin—only the 2nd molar (right) and the 1st and 2nd molar (left) were *in situ* and complete. The non-erupted 3rd molars of both sides were missing.

Ossa Innominata

Both right and left halves were defective in regard to much of their iliac and pubic portions, but the ischial areas were more complete. The right acetabulum was nearly complete, but that of the left side lacked the pubic portion. The acetabular cavities were not completely ossified, the lines of the bony sutures being still well marked.

The Left Femur

Two fragments, an upper comprising the head, neck, and portion of the great trochanter, and the lower epiphysis complete. The upper portion had separated into two parts, probably as a result of handling since the discovery, the head having come away from the neck. The head does not, however overlap the neck when fitted back into position, pointing to ossification not having been complete.

From the foregoing it may be concluded that the skeletal remains are from the one individual, an immature Tasmanian aboriginal. The characters of the sutures and dentition of the cranium indicate an age of 16-17 years, possibly less.

The racial characters, while not so strongly marked as in an adult skull, are definitely Tasmanian. The weight and size of the bones (especially those of the pelvis) point to their being those of a female. None of the bones show signs of attempt at incineration or damage from teeth of carnivorous animals.

The Method of Disposal of the Dead

The methods by which the extinct Tasmanians disposed of their dead have been summarized by Ling Roth (1899). Instances of disposal of individual bodies have been described by Péron (1807, p. 265), Calder (1875. p. 27), Pulleine (1924, p. 83), and Crowther (1934, p. 22). In some cases the body was bound in a strongly-flexed position and was usually either incinerated or left in a hollow tree. The position of flexion was not attempted in all cases, and many remains have been discovered in sand-dunes and elsewhere that appear to have been simply left where they died without any attempt at systematic disposal. Many observers speak of the widespread habit of the Tasmanians of wearing bones of their relatives, either suspended around their neck or carried in receptacles. Pulleine (*ibid*) describes a case in which the remains were contained in a skin bag which were found in a recess in a sandstone scarp high up on the shoulder of Mt. Nicholas, a discovery very comparable in site and nature to that described on Mt. Dromedary.

It may be concluded that the remains found at the latter site are those of an immature Tasmanian aboriginal placed there by a relative in accordance with the accepted custom of the race.

Acknowledgements

Thanks are due to Mr. Hedley Johnson who discovered the bones; to his mother, Mrs. I. Johnson of Upper Dromedary, who was instrumental in placing them at the disposal of the Tasmanian Museum; and to the Police Department, for assistance in regard to the investigation.

References

Calder, J. E., 1875.—*Some Account of the Native Tribes of Tasmania.*

Crowther, W. E. L. H., 1934.—Notes on the Habits of the Extinct Tas. Race, No. 3: Disposal of their Dead. *Pap. Roy. Soc. Tasmania,* 1933 (1934).

Ling Roth, H., 1899.—*The Aborigines of Tasmania.*

Peron, F., 1807.—*Voyage de découvertes aux Tetres Australes.*

Pulleine, R., 1924.—On the Discovery of supposed Aboriginal Remains near Cornwall, Tasmania. *Trans. R. Soc. of S. Australia,* 1924, pp. 83-86.

The Development of the Guano Trade from Hobart Town in the Fifties and Sixties

By

W. E. L. H. Crowther

(Read 14th November, 1938)

Within recent years there has been a marked return of interest in the remote islands of the Pacific, since these islands have now acquired a strategic value on account of the Empire and Pan-American Flying Routes. In the following pages an attempt has been made to link up their history with the development of the guano industry from Hobart Town by the ships employed by the late Hon. W. L. Crowther, F.R.C.S., C.M.Z.S. in his whaling and timber interests.

Islands Adjacent to Tasmania

Lawrence Rocks—
Mt. Chappel Island—
Breaksea Island—

The Lawrence Islands, near Portland, Bass Strait, were the first exploited. Here in 1854 the little ships *Union, Flying Squirrel,* and *Scotia* were employed taking guano, which was sold at Hobart Town at £8 per ton.

A report ('Hobart Town Advertiser', 6th April, 1854) states that there was a great quantity of guano, which was filled into bags and so loaded into open boats, from a platform about 18 feet above a rocky ledge. Upon this latter the stern of the boat was grounded, the remainder being afloat in deep water and often exposed to a heavy swell. Such a method of loading must have been dangerous and wearing to both men and boats.

A lease of Mt. Chappel Island, in order to take guano, was applied for by W. L. Crowther from the Government of Tasmania. He was not alone in the field, however, as a Mr. Askunas of Melbourne, having purchased information as to the presence of guano there,

approached the Government with the same request, offering a rental of £500 a year for four years. The Minister concerned, believing the guano to be of immense value, decided to suspend the Waste Lands Act, under which the application for the lease had been made, and refused Crowther's offer. In no way discouraged, the latter landed his working parties on the Island and commenced to bag up the guano for shipment.

Askunas acted promptly and chartered a vessel, the *Boomerang*, at Melbourne to proceed to the Island. On landing, her crew were set upon and driven back to their ship which returned to Queenscliff. Heavily reinforced, the *Boomerang* returned to Mt. Chappel. One man dressed as a constable read a document with an imposing seal (it was stated after in evidence that it came from a pickle bottle), which claimed to give the newcomer legal possession. As a result of this stratagem or of superior force, Crowther's party withdrew to their boats, when the *Boomerang's* crew completed the filling of the bags, and, with the guano already procured, loaded their ship and left for Melbourne.

In an action Crowther *v.* Askunas held at Hobart ('Mercury', September 18th, 1861), the plaintiff was not successful. His contention that to be in possession was equivalent to a title, not being sustained.

In a long letter to the same paper (August 1st, 1861) Crowther pointed out that the deposits were of a very limited extent. He warned farmers and the public that, except for 300 tons of pure guano at the site of a cormorant rookery, all of which had been removed by the *Boomerang*, no deposits existed elsewhere on the Bass Strait Islands. He gave an analysis of an extensive deposit immediately below the surface on Mt. Chappel, which was principally carbonate of lime, and valuable phosphates being present only in traces.

An account of this controversy with the Government as to the Bass Strait islands is given in considerable detail in Tasmanian Parliament Paper No. 38 (1861). The matter, however, settled itself when it was realised that, except for an odd deposit at a site of a rookery, guano in commercial quantities did not exist. It is of interest to note that among the leases applied for by Mr. Askunas was that of Cat Island, on which the preservation of the gannet rookery is a matter of Government interest at the present time.

Crowther made one more effort, this time from Breaksea Island near Port Davey. From this site a cargo was obtained by his whalers, and his ship the *Juno* was loaded and despatched to Ipswich, England. When analyzed on arrival, it was found that the cargo was only a light sandy soil almost without fertilizing properties. His heavy loss convinced him that guano had to be found in dry tropical or sub-tropical climate, and he sent his whalers to make a systematic search for suitable islands in such latitudes.

ISLANDS IN THE CORAL SEA

Wreck Reef and Islets	22. 10. 30. S. Lat. 155. 28. 40. E. Long.
Bell Cay, Swaines Reef	21. 42. S. Lat. 151. 20. E. Long.
Raine Island	11. 35. 50. S. Lat. 144. 2. 20. E. Long.
Bramble Cay	9. 7. 50. S. Lat. 143. 52. 10. E. Long.
Brampton Shoal and Islets	18. 49. } S. Lat. { 158. 2. 6. } E. Long. 19. 35. } { 185. 4. 3. }
Pilgrim Island	24° S. Lat. 104° W. Long.
Lady Elliot's Island	6. 6. S. Lat. 152. 40. W. Long.

The Coral Sea may be regarded as that area lying between the coast of Queensland and Noumea on the one hand and New Guinea and Norfolk Island on the other. The visits of Crowther's own whalers to this region must have made him familiar with the existence of islands and reefs supporting the rookeries of innumerable sea birds.

Personal contact with the officers of H.M.S. *Fly* and *Bramble* when refitting at Hobart Town after surveying these seas strengthened his intention to lease and work certain reefs and islands. To this end, with another (? E. I. Chapman) he formed the Anglo-Australian Guano Company early in 1861. On March 4th of that year a schooner, the *Harp*, was chartered and cleared in ballast for Guam. To clear for Guam was a common custom at this time when an owner did not wish to disclose the destination of his vessel. News, however, was received on July 5th that the *Harp* had been wrecked on Bird Island, fortunately without loss of life.

Bird Island which is part of Wreck Reef is low, about one mile in circumference, and surrounded, except in one part, by a coral reef. The anchorage is very unsafe and cannot be used by shipping during the hurricane season. Here Flinders' ship, the *Porpoise*, was lost in 1802.

Several Tasmanian vessels were lost in this vicinity in succeeding years, and a list of them is given in Appendix A. At this period gold had been discovered in Gabriel's Gully near Otago, New Zealand, and, to convey diggers and supplies to that port my grandfather had called in two of his whalers, the *Isabella* and *Flying Squirrel*, and opened up a regular shipping service between Hobart Town and Dunedin.

On June 6th, 1862, the little schooner *Flying Squirrel* (79 tons) left Dunedin for the ' Polynesian Group,' where she took in 100 tons of guano, returning with it to Hobart Town, whence she sailed on September 16th for Dunedin with timber from Crowther's mills at Oyster Cove.

By January 10th, 1863, the secret and details of the new venture were widely known, as a despatch from the Secretary of State, dated October 27th, 1862, confirmed the action of H.M. Government in granting to the Company an exclusive occupation for a term of years of certain guano islands in the South Pacific area. The islands and their locations are given above. The lease was to be for seven years in each case, and authority was given to erect buildings, &c., on the islands. Instructions as to maintenance of the personnel and their discipline also were laid down. This agreement also provided that a statement should be made each half year of vessels lifting guano and the total tonnage taken. Royalties were to be paid at the rate of 2s. per ton of guano for the first two years, and at the rate of 4s. per ton for the remaining five years. Such a concession aroused great interest at Hobart Town, and the 'Mercury' four days later commented in a very laudatory manner on the enterprise of their fellow citizen.

Dr. Crowther's largest whaler, the *Offley*, was called in and fitted to take guano whilst whaling on the out and home passages. A schooner, the *Northern Lights*, was purchased to engage in the trade.

An interesting legal position arose on March 13th, 1863, when the *Offley* was refused a clearance by the Customs Department. It was contended that, although as a whaler she had exemption from light and port dues, this exemption did not cover the carrying of guano. The sum claimed, £15 13s. 4., was paid under protest the next day, but recovered with costs as a result of legal action taken some weeks later.

Some dislocation of Crowther's fleet was caused by the outbreak of the Maori War. The *Isabella*, having been chartered to convey troops to New Zealand, was refitted for that purpose. On August 16th, 1863, she sailed from Hobart Town with seven officers and 110 other ranks of the 12th and 40th Regiments. Another whaler, the *Sapphire*, was called in from the whaling grounds and laid on for Bird Island, whence she arrived on December 14th with 320 tons of guano.

So far all seemed well with the industry. Guano was coming in freely by Crowther's ships, and by at least one chartered vessel, the *Daniel Watson*, and there was a ready market established in Tasmania as well as at Melbourne, Adelaide, and as far as New Zealand. The time seemed ripe to extend the venture.

On April 16th, 1864, Mackay's launched for Crowther a schooner called by (his wife's) name, *Marie Louise*. The new vessel of 50 tons, rigged as a fore-and-aft schooner, was designed to explore the Pacific Ocean for new guano deposits.

At this time the *Offley*, *Juno*, *Sapphire*, and *Pryde* (brig.) were on the Bird Island trade with the *Sapphire* and *Isabella* maintaining the Dunedin service and calling at Bird Island on the homeward run.

The 'Mercury' of October 10th, 1864, reported the arrival of the *Sapphire* from Bird Island via Lady Elliot Island. This island (6° 6′ S. and 152° 40′ W.) is a dependency of the Queensland Government, and was leased to Crowther for a period of ten years from the 10th November, 1863, at a rental of £300 per annum for the first three years. It was also provided that 200 tons of guano per year were to be available for sale at Queensland ports. Other conditions of the lease were very similar to those laid down by His Majesty's Government for the other islands. Shore parties were permanently established on Bird and Lady Elliot Islands, their services being for twelve months, with a relief at the end of that time. They worked on a wage, getting out the guano and bringing it in by trucks to sheds. Here it was bagged ready for transport to the vessels lying at anchor off shore. It was carried between the shore and the ships by whale boats, and these boats were sheathed with metal in order to minimize wear by friction on the coral and also to avoid destruction by the teredo.

This year the *Sapphire* made the voyage out and home in less than six weeks, shipping 360 tons from open boats. The *Isabella, Britons Queen,* and *Offley* brought a series of cargoes—the last-named calling at Auckland. Production generally had been steadily increasing There are no figures for 1860, -1, -2; 1863 - 462 tons; 1864 - 854 tons, and an estimate of 1600 tons for 1865.

An important development now took place. On August 1st, 1865, a prospectus was issued in order to reorganize the Company. The Anglo-Australian Guano Company Ltd. was formed with a capital of £60,000 in 3000 shares each of £20. Henry Hopkins, Esq., was appointed Chairman of Directors. Dr. Crowther accepted £10,000 as purchase-money in fully paid-up shares, and made over to the Company his rights to the guano on the islands leased from His Majesty's Government and the Government of Queensland, as well as ships, various stores, guano in the sheds, with tramways and buildings on the islands.

Captain J. W. Robinson was appointed Manager at Lady Elliot Island, and on September 30th, 1865, landed with his family and twelve labourers, and brought 30,000 feet of sawn timber from the Oyster Cove Mill with which to erect permanent works. Captain Robinson's journal, in the writer's possession, gives details as to the daily routine of collecting and loading guano.

The island itself was a coral island, about 3½ miles long by 2½ miles across, situated about 60 miles from Rockhampton, and was occupied by countless sea birds.

Conditions for ships were greatly improved in 1867, when the *Macquarie* laid down permanent moorings in the hope of attracting overseas as well as inter-colonial trade. Captain Robinson also caused a permanent light to be erected on a mast 85 feet above sea level.

During the Summer (hurricane) months no ships loaded, and the men were employed filling the huts with guano.

ISLANDS IN THE S. PACIFIC AREA

Teinhourn	10. 20. S. Lat.	150. W. Long.
Roggewein	11. .... S. Lat.	156. W. Long.
Bauman	12. .... S. Lat.	154. W. Long.
Christmas Is.	1. 57. N. Lat.	157. 27. W. Long.
Ducies Is.	24. 40. S. Lat.	124. 48. W. Long.
Cato's Is.	23. 15. S. Lat.	115. 34. W. Long.

In the months preceding the formation of the new Company His Majesty's Government granted to Crowther the lease of the above islands as well as Pilgrim Island and Bramble Cay. He fitted out the *Marie Louise* under Captain Pie to report upon their capabilities and look for new islets. Entering out for Bird Island on January 18th, 1866, she was not reported until her arrival at Brisbane on July 10th. In the interval she had visited the Navigators (Samoa), Ducies Island, Christmas Island, and according to family tradition had sailed nearly to the coast of South America. During this cruise the mate, Mr. Bradley, fell from aloft, and was paralyzed for the remainder of his life.

The barque, *Elgin*, in 1873 found a corked bottle on Ducies Island embedded in a heap of stones. In it was a message which read: 'Exploring vessel *Marie Louise* of Hobart Town off Ducies Island, April 5th, 1866—Crew all well—Bound from here to Christmas Island.' Upon her return she was sold, and was eventually wrecked at the Fiji's in 1871.

In 1866 Crowther had been involved in a controversy with the Tasmanian Government. Approval of leases from the Home Government had not been transmitted to him for six months after their arrival, and in this way he had suffered considerable loss.

By this time the administration of all guano leases from the Antarctic to 10° S. of the Equator and between latitudes 170 W. and 75 E. had been placed under the administration of the Governor of New South Wales. These islands, however, did not carry guano in sufficient quantity, and were not worked by him. In consequence His Majesty's Government in February, 1869, revoked the licences for Teinhourn, Roggewein, Bauman, and Pilgrim Islands upon the grounds that they could not be located, though shown on Admiralty Charts, and also that the stipulated quantity of guano had not been removed from them. The lessee was also required to pay arrears of rent at £100 per annum per island for Ducies, Cato, Christmas, and Raines Islands in addition to such other sums as might be due.

The association of Launceston with the Anglo-Australian Guano Co. Ltd., and the latter year of its work, cannot be dealt with here. Nor can the work of Captain Crosby and the discovery of guano (phosphate rock) at Ocean Island.

With the opening up of the Trans-Pacific Air Routes considerable controversy has arisen between the British Government and that of the United States as to the sovereignty of Christmas Island and other islands. It is of historic interest in this regard that as far back as 1865 such islands were in the possession of Great Britain, and one at least was actually leased to a British subject for the taking of guano.

Appendix A

Wrecks and Boat Voyages Associated with Guano Islands

Harp (Schooner) .... Lost Bird Is., 1861.

Golden City (Ship) .... Lost Bird Is., July 13th, 1866.

Briton's Queen (Schooner) . Lost Mast Head Is.

Cosmopolite (Brig.) .... Lost Mast Head Is., Nov., 1866.

Wolverine (Brig.) .... Lost Bird Is., with all hands, June, 1878.

Annie (Schooner) .... Lost Bird Is., Aug. 2nd, 1882.

Lone Star (Brigantine) .. . Lost Wreck Reef, Sept. 10th, 1871.

Isabella (Barque) .... Lost Cape Barren Is., with guano.

Notable Voyages

Lone Star .. . . Capt. Clark, with three men in a small boat, over 300 miles to the Queensland Coast.

Annie .... An almost similar voyage by the ship's boat.

Prairie .... Voyage with two men (sole survivors of the crew), west about from Torres Straits to Hobart.

Alice Maud (Cutter, 16 tons) An exploring voyage, September 27th, 1875, to Torres Straits.

Marie Louise .... Exploring voyage, as stated, to S. Pacific Ocean, 1865.

Appendix B

Sources of Information

Captain A. B. Robinson, 1865-67 .... Personally given. Copies of correspondence between his father, Capt. J. W. Robinson, and the A.A. Guano Co., and Harbour-Master of Rockhampton.

Log Books .... *Bird Is.*, Oct. 10th, 1873-May 20th, 1874, Captain Strachan.

Log Books .... *Lady Elliot Is.*, 11th Nov., 1864-Sept. 12th, 1865. Capt. J. W. Robinson.

Log Books .... *Lady Elliot Is.*, . . . 1872-May 3rd, 1872.

Log Books .... Barque *Offley*, Jan. 21st, 1864; Dec. 28th, 1864. Capt. J. W. Robinson.

A.A. Guano Company .... Prospectus, 1865.

A.A. Guano Company .... Annual Report, 1869.

A.A. Guano Company .... Chart of Bird Is. and MS. letters, W. L. Crowther and Henry Hopkins. List of shareholders and balance-sheets.

Guano .... Parliamentary Paper: 1861, No. 38, Tas. Govt.

Despatches: H.M. Government .... Lease of Certain Islands: Tas. No. 39. July 5th, 1863.
Dismission of Leases: Tas. No. 18. Feb. 17th, 1869.

Lease of Lady Elliot Is. .... Copy of Indenture: Q. Govt.
Further Correspondence, Aug. 6th, 1866; Oct. 20th, 1866.

Newspapers of the period, especially files of the 'Mercury.'

There is a considerable file at the Mitchell Library dealing with the A.A. Guano Co. Ltd., which the writer has not been able to examine fully.

Most of the above are in the possession of the writer.

Pap. & Proc. Roy. Soc. Tasmania, 1938 (24th May, 1939)

Relationships of the Tasmanian Canoe-Raft

By

Joseph Pearson

(Read 14th November, 1938)

Perhaps the most primitive type of floating craft still in use is made of bundles of bark or reeds which are tied together. Such a craft has a very short life, and can only be used within a very restricted range. This type was probably followed by the catamaran, (1) in which two or three logs of wood are tied together. The catamaran, which is still to be found in Southern India, Ceylon, and parts of the East Indies, is a more permanent type than the first, and has a larger range. Frequently a small triangular sail is used, which enables the catamaran to run before the wind at a considerable speed. The dug-out canoe, which might be regarded as the third stage in the evolution of the boat, is still used in many parts of the world, with or without an outrigger. It was succeeded by the planked boat, in which the planks were first stitched together and at a later period were fastened together by pegs or nails.

The object of the present note is to draw attention to the interesting distribution of the first of these types, which is so well-known to students of Tasmanian ethnology. It is not necessary to describe the Tasmanian canoe-raft since adequate descriptions in considerable detail have already been given by various writers, and our knowledge of this subject has been admirably summarized in this Journal (Meston, 1936). Fig. 1 depicts one type of Tasmanian canoe-raft, which consisted of three independent bundles of bark, a larger central

(1) Derived from a Tamil word which means literally 'tied-wood.'

one, to which were lashed two smaller lateral bundles. Such a craft was probably pointed at both ends. It is interesting to note that the *balsa*, a canoe-raft used in South America (fig. 2), has a marked

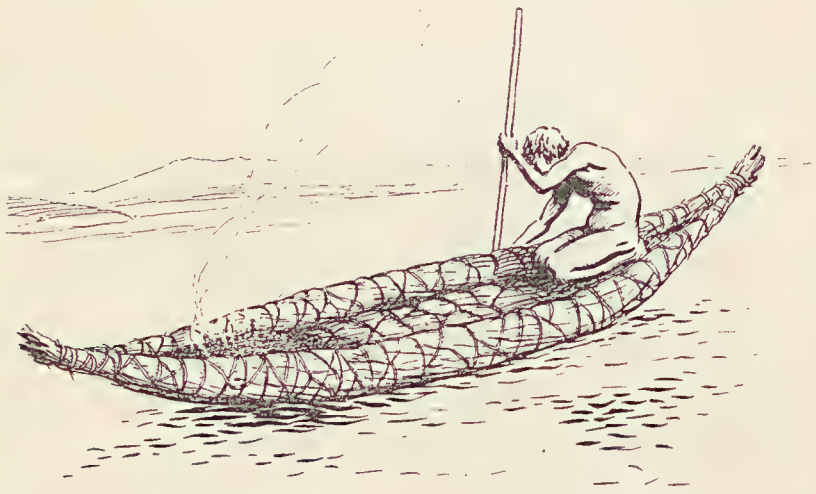

Fig. 1.—Tasmanian bark canoe-raft (after a small model in the Tasmanian Museum).

affinity with the Tasmanian canoe, though probably more seaworthy. H. Cary Gilson (1938) has given an interesting description of the balsa used on Lake Titicaca. The balsa is a raft consisting of huge bundles of sedge, known as *tortora (Scirpus tortora)*, which are tied together with ropes of plaited grass. These craft last for only about two or three months, after which they break up and are then eaten by the cattle. Gilson describes two types, a smaller craft 8 to 10 feet long, which carries one man, and a larger kind, used for general transport, which may be as much as 20 feet long, and which carries a matting sail made of tortora (shown in the stern of the boat, fig. 2). I understand that the balsa is also used in the sea along the Peruvian coast, but I have no confirmation of this.

A third type of craft which is used on Lake Tana, Abyssinia, is shown in fig. 3. I have been unable to obtain a precise description of this canoe, but it is apparently made of reeds, which are lashed together. This craft is probably somewhat similar to the one used on Lake Chad, Central Africa, of which a short description is given by P. H. Lamb (1921). The canoe-raft of Lake Chad is made of reeds, and Lamb states that the life of such craft is not more than one month. It is interesting to note that a somewhat similar type of boat was used by the Egyptians about 3500 B.C. The Egyptian type differed from the Abyssinian in having a high prow and stern, and was similar in this respect to one type of Tasmanian canoe-raft.

Thus, the same general type of canoe-raft is found in three widely separated parts of the world. What is the explanation of this discontinuous distribution?

In the field of Biology there are many instances of organisms bearing close resemblances to each other which are found thousands of miles

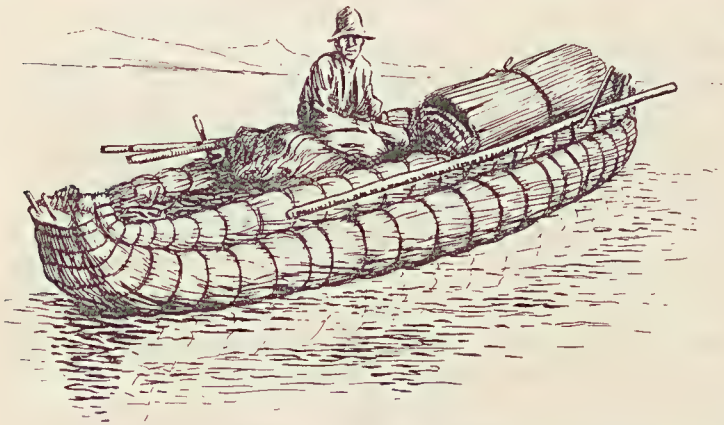

Fig. 2.—*Balsa*, Lake Titicaca (after H. Cary Gilson, by courtesy of the Editor, *The Geographical Journal*).

apart. In most cases this common likeness is due to a common descent (homogeny), and the broken distribution marks the outposts of what was once a large continuous area within which these related forms had arisen from a common ancestral type. In some cases, however, the resemblances are produced merely by the convergence of unrelated forms towards similarity of structure, due to the effects of similar environmental conditions (homoplasy).

If it is legitimate to make use of this biological parallel in the present case, it would appear either that these primitive canoe-rafts had a common origin, scattered and broken though their distribution has become, or, on the other hand, that they may have arisen independently in several widely-separate parts of the world in response to similar requirements in a similar set of circumstances.

The solution of this interesting problem has an important bearing on another question, viz., the route by which the Tasmanian aborigines reached Tasmania. If, as it is widely believed, they came by slow stages down the east coast of Australia after having reached that continent from the neighbouring islands of the West Pacific or the East Indies, then it is reasonable to suppose that they brought with them, as part of their primitive culture, the art of making bark canoe-rafts—an art which they retained to the end of their days. If such were the case, the Tasmanian canoe-raft was probably a homogenetic structure

and came from the same common stock from which the African and American canoe-rafts arose. It is conceivable that these products of an early and primitive culture were evolved near the cradle of the human race, which is said to have been somewhere near the south-western part of Central Asia. From that focal centre the primitive craftsmanship would radiate in all directions where the absence of geographical and climatic barriers permitted, either by the actual migration of races who carried with them their special ethnological characteristics, or by means of the actual diffusion of culture from one race to another. Both influences were undoubtedly at work, and it is not difficult to visualize how the use of the canoe-raft would spread in may directions for a considerable distance from its point of origin and ultimately would cover a very large geographical area. In course of time this area would tend to become broken either through the abandonment of the handicraft by some races, or because, in the hands of a race possessing a relatively high degree of intelligence, it would be changed into something quite different. Biologically speaking, this may be regarded as a reasonable homogenetic explanation of the occurrence of the bark or reed canoe-rafts in three isolated parts of the world far removed from their probable centre of origin, and would incidentally explain how the canoe-raft came to Tasmania.

On the other hand, Professor Wood Jones (1935) has written strongly in favour of the view that the aborigines reached Tasmania direct by sea from their earlier home somewhere in the West Pacific.

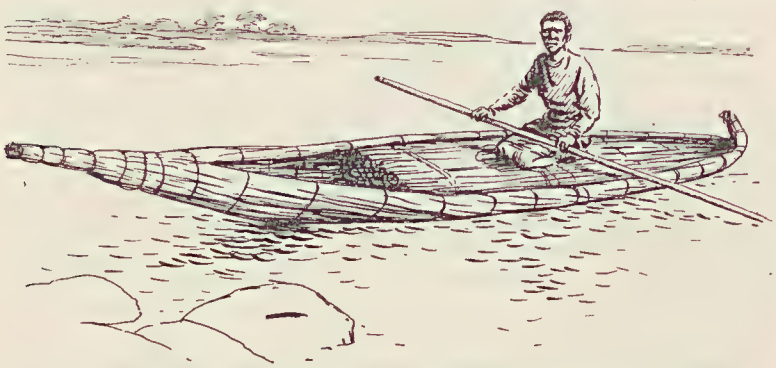

Fig 3.—Primitive canoe-raft, Lake Tsana, Abyssinia (after a photograph published in *The Auckland Star*).

Such a view postulates the possession by the early Tasmanians of ocean-going canoes and not the primitive unseaworthy canoe-raft which we know they possessed in their last years. In support of his thesis that the Tasmanians once possessed the art of making sea-going canoes, which at a later period they lost, Wood Jones wrote as follows (1935, p. 8.) 'we know quite well that a race that has come

by sea to a new home may, in the end, forget the craft of boat-building, *when ocean voyages are no longer required* (1). Even if the Tasmanians had possessed no knowledge of boat and boating during the period of European contact, the claims for their seacoming would not necessarily have been invalid.'

I have italicized part of the above quotation because therein lies the crux of the position. Tasmania is surrounded by numerous small islands which are separated from the main island by stormy seas and fierce currents, yet there is undisputed evidence that the aborigines visited many of these islands. Obviously, then, there was a definite need for seaworthy boats, and, if the aborigines had possessed such boats when they first arrived, there is every reason to believe that out of sheer necessity they would have retained the important art of boat-building.

If Wood Jones is correct, it would follow that the Tasmanian bark canoe-raft was probably evolved independently in Tasmania and had no relationship with similar types of raft in other parts of the world, and was, in fact, a remarkable example of convergence.

It does not come within the scope of the present paper to examine critically the various arguments which Wood Jones has put forward in support of his view, particularly as this has already been done to some extent by Meston (1937), or to weigh the evidence regarding the homogenetic or homoplastic origin of the canoe-raft.

It may be said, however, that not one shred of material evidence has been adduced in support of the view that the Tasmanians once possessed the art of building sea-going canoes. My personal opinion is that the primitive canoe-raft of the Tasmanians was a homogenetic cultural product brought by them from their original home and retained by them throughout their long and protracted journey eastward along the islands of Southern Asia and southward down the eastern coast of Australia to their final home in Tasmania.

I am indebted to Captain D. Colbron Pearse for the figures which illustrate this paper.

(1) The italics are mine.

References

Gilson, H. Cary, 1938.—The Percy Sladen Expedition to Lake Titicaca, 1937. *Geogr. Journ.* vol. XCI, No. 6. June, 1938. pp. 533-538.

Jones, F. Wood, 1935.—*Tasmania's Vanished Race*, published by the Australian Broadcasting Commission.

Lamb, P. H., 1921.—Notes on a visit to Lake Chad. *Geogr. Jour.* vol. LVIII, No. 6. Dec., 1921, pp. 443-446.

Meston, A. L., 1936.—Observations on Visits of the Tasmanian Aborigines to the Hunter Islands. *Pap. Roy. Soc. Tas.*, 1935 (1936). pp. 155-162.

————————, 1937.—The Problem of the Tasmanian Aborigine. *Pap. Roy Soc. Tas.*, 1936 (1937), pp. 85-92.

The Royal Society of Tasmania

Annual Report

1938

The Annual Meeting was held in the Society's Room, Tasmanian Museum and Art Gallery, Hobart, on the 14th March, 1938.

The following office-bearers were elected:—

Vice-Presidents: Dr. A. N. Lewis (for one year).
Dr. W. L. Crowther (for two years).

Treasurer: Mr. S. Angel.

The following members of Council were elected:—

Mr. W. H. Clemes (retiring 1939).
Professor A. L. McAulay (retiring 1939).
Mr. W. H. Hudspeth (retiring 1940).
Mr. J. W. Evans (retiring 1940).
Hon. L. M. Shoobridge (retiring 1941).
Mr. E. E. Unwin (retiring 1941).

The Council made the following appointments at its first meeting:—

Secretary and Librarian: Dr. Joseph Pearson.
Assistant Librarian: Mrs. Clive Lord.
Standing Committee: Dr. A. N. Lewis, Dr. W. L. Crowther, Mr. W. H. Hudspeth, and the Secretary.

The Council elected the following five Trustees to serve on the Board of Trustees of the Tasmanian Museum and Art Gallery and the Botanical Gardens:—W. H. Clemes, W. L. Crowther, W. H. Hudspeth, A. N. Lewis, and L. M. Shoobridge.

The Society's President, His Excellency Sir Ernest Clark, K.C.B., K.C.M.G., C.B.E., went to England on leave from May to September and the Secretary, Dr. Joseph Pearson, was on leave in England for six months. During his absence Mr. J. W. Evans acted as Secretary.

Nine meetings have been held during the year (see proceedings for abstract of papers). In addition scientific papers were submitted for publication and have been printed in the present volume.

Library

The Society's Library continues to be used extensively by members. During the year 283 new volumes were added to the Library as gifts from 274 institutions in exchange for the Society's Papers and Proceedings and by purchase. The Library now consists of 19,267 volumes. The Council wishes to place on record the valuable work done by Mrs. Clive Lord, Assistant Librarian.

During the year a new type of book cover was introduced for loose parts of unbound volumes. About 1250 covers were made during the year. The Council acknowledges gratefully the following donations towards the cost of the book covers:—His Excellency the Governor, £1; Lady Clark, £1; Dr. W. L. Crowther, £1; Mr. H. Allport, £1; and Mrs. B. Sheppard, 5s.

Membership

The Society consists of the following members:—

	1938.	1937.
Honorary Members	2	2
Corresponding Members	3	3
Life Members	7	7
Ordinary Members	232	231*
Total	244	244

During the year 11 names were removed from the membership owing to deaths, resignations, &c., and 12 new names were added.

The Council regrets having to record the deaths of the following members during the year:—

Life Member: N. Oldham.

Ordinary Members: James Marsh, H. H. Scott, Dr. Stoddart Barr, and Hon. A. Wardlaw, C.M.G.

New Rules

The Rules of the Society have been revised and reprinted during the year.

Index

The Index of the Papers and Proceedings has been brought up to date and it is hoped to publish it during 1939.

* The number of members given in the Report for 1937 should have read 231 instead of 241.

Clive Lord Memorial Prize

In the present year the Council decided to proceed to the award of the first Clive Lord Memorial Prize, and the conditions governing the award were advertised in the press.

It was decided that the final date for the receipt of essays should be January 31st, 1939.

Printing of Papers and Proceedings

Once again the Government has very generously printed the Papers and Proceedings. The Council wishes to record its appreciation of this generous assistance.

Abstract of Proceedings

1938

14th March, 1938

Annual Meeting

The annual meeting was held in the Society's Room, Tasmanian Museum. The President, His Excellency the Governor, Sir Ernest Clark, K.C.B., C.B.E., presided.

A vote of sympathy was passed to the family of the late Mr. H. H. Scott, formerly Curator of the Queen Victoria Museum, Launceston, members carrying this standing.

The following were elected Office-bearers and Members of the Council for 1938:—Vice-Presidents, Dr W. L. Crowther and Dr. A. N. Lewis; Treasurer, Mr. S. Angel; Council, Mr. W. H. Clemes, Mr. J. W. Evans, Mr. W. H. Hudspeth, Hon. L. M. Shoobridge, Mr. E. E. Unwin.

Mr. Walter E. Taylor was appointed Hon. Auditor.

Mr. F. H. Foster was elected a life-member of the Society.

Dr. A. N. Lewis explained the alteration of the Society's representation on the Museum and Botanical Gardens Trust under the amendment of the Tasmanian Museum and Botanical Gardens Act, 1885.

Dr. Hickman exhibited some Tasmanian Ascidians.

Dr. C. F. Hodgkinson delivered an illustrated lecture on ' Colourful Ceylon.'

11th April, 1938

A meeting was held in the Society's Room on this date, the President, His Excellency the Governor, presiding.

The following were elected members of the Society:—Miss Josephine Peterson, Mr. R. B. Wood, Mr. J. L. Somerville, Mr. T. Raphael, Mr. N. J. B. Plomley, Mr. M. P. Crisp, Mr. R. A. Sherwin.

Dr. Lewis exhibited several specimens of Tasmanian Trilobites.

Dr. H. D. Gordon gave an illustrated lecture on ' Seaweeds,' of which the following is an abstract:—

> There are three classes of seaweeds—green, brown, and red. This classification is not so arbitrary as it sounds, for the differences in colour are associated with important differences in structure and life history. All seaweeds contain the green pigment chlorophyll, but some have additional pigments which mask the green colour. These pigments seem to be of importance in relation to the quality of light penetrating to various depths in the water; generally speaking the green seaweeds occur fairly near high water mark, the browns can extend much farther down, whilst the greatest depths are achieved by some of the reds. Ability to withstand drying is also an important factor controlling the distribution of various species

above low water mark, and may lead to their arrangement in distinct zones. Some species are not confined to one zone, but are to be found higher up the tide range in summer than in winter, or vice versa, in response to the seasonal changes in temperature and light intensity respectively.

As seaweeds absorb their food-materials all over their surface, and not through any root system which must live in the soil, they may grow attached to rocks, &c., or to other seaweeds, and in fact practically every seaweed of any size can be found to have smaller ones attached to it, though they are very seldom parasitic. The uniformity of the aquatic environment is reflected in a relatively simple anatomical structure, though the external forms of seaweeds are extremely varied.

Every substance occurring on the land finds its way, in greater or less quantity, into the sea, and an extraordinary variety of substances is absorbed by seaweeds and can be extracted from them. Iodine is prepared commercially in this way—a process which will become more important as other sources are exhausted. The iodine and other elements found in seaweeds give them a considerable food value, and refined food products have been prepared from seaweeds, whilst "Dulse" (*Rhodymenia palmata*) and others are eaten in their natural state in various parts of the world. Most seaweeds yield large amounts of gelatinous substances and several are used in cookery for that reason, especially *Chondrus crispus*, or Irish Moss, which is also used in the preparation of cosmetics, paints, boot polish, shaving soap, and a variety of other products, besides having medicinal importance as a demulcent. Some seaweeds accumulate lime and play a part in the formation of coral reefs.

A number of lantern slides were used to illustrate the structure and the reproductive processes of various types of seaweeds, and a collection of mounted specimens of British and Tasmanian seaweeds was exhibited.

Dr. Lewis took the opportunity of wishing His Excellency God-speed and a safe return from England, and His Excellency replied briefly.

9TH MAY, 1938

A meeting was held in the Society's Room. In the absence of the President, Dr. A. N. Lewis presided.

The following members were elected:—Mr. M. C. Taylor, Mr. F. W. Hicks.

Mr. Henry Allport spoke about encroachments on certain streets in Hobart and exhibited original grants of town allotments.

Mrs. J. A. McElroy gave a paper (read by Mr. W. H. Hudspeth) on 'Lieutenant-Governor Collins and his Royal Marines,' of which the following is an abstract:—

The paper dealt briefly with Collins' military record, his part in the establishment of the colony at Port Jackson and his history of the first years of the settlement there. Then followed a sketch of the formation and distinguished achievements of the Royal Marine Corps, a detatchment of which formed Collins' military force at the founding of Hobart, and an extract from his Garrison Order Book showed the pride with which he ordered a thanksgiving service for the victory of Trafalgar, even though his settlement was on the verge of starvation. Governor Collins' undoubted memorial, raised by his contemporaries and called after him, was old St. David's Church, and, so far, there is no evidence to show that the wooden building

begun near his grave in the burying-ground was ever completed, consecrated, or used for Divine Service. The existing monument, with the badge of the Royal Marines, was sanctioned by Governor Arthur and erected in Sir John Franklin's term of office.

Dr. W. L. Crowther read a paper on 'The Guano Islands of the 60's and 70's' (see p. 213 of the present volume).

Mr. S. Angel read a paper on 'Notes on the last of the Tasmanian Race,' of which the following is an abstract:—

At the beginning of the Nineteenth Century, when the sealing industry flourished in the Bass Strait, it was a common practice for the sealers, who were mostly escaped convicts or ticket-of-leave men, to abduct native Tasmanian women to assist in capturing the seals. In the search for new sealing grounds most of the islands off the southern coast of Australia were visited, and Kangaroo Island (South Australia) became a favourite resort, as it provided salt for the preparation of the skins and had the advantage to them of being outside the jurisdiction of the Van Diemen's Land Government.

There are records of several Tasmanian women who lived on Kangaroo Island prior to the colonisation of South Australia in 1836, but, unfortunately, details of their lives have not been officially kept, so that there is some doubt as to the dates of their deaths. The Southern Australian Census for 1866, in dealing with the native population of Kangaroo Island, records 'Four natives of Van Diemen's Land' and several old residents have stated that 'one, if not three,' of them survived after the death of Truganini in 1876. Only one of these women (Betty Thomas) left any children, namely, a son who went to sea, and two daughters afterwards known as Mrs. Mary Seymour and Mrs. Simpson. Grandsons of Betty named Stanford ('Tiger') Simpson and Joseph Seymour were interviewed by Mr. Norman B. Tindale of the Adelaide Museum in 1936 and were able to direct him to the site of two old huts where several flint implements of Tasmanian facies were found. They also supplied a few native phrases said to be in the Hobart dialect which Betty had taught them in their childhood, one word of which appears in Milligan's Tasmanian vocabulary.

Mr. Tindale has been successful in tracing a Minute by the Destitute Board, Adelaide, in dealing with an application for rations on behalf of Mary Seymour, which states:—

'There were three Tasmanian women, native blood, living in Kangaroo Island for many years, the last of these aborigines died about six years ago. 8/9/94.'

References in early South Australian history point to at least four Tasmanians living on Kangaroo Island in 1836, namely:—

(1) Sally (known also as 'Bumble-foot' or 'Big Sal'). Taken to Kangaroo Island by Meredith, who was murdered at Yankalilla in 1834. Was tried with 'Suke' for complicity in the murder but discharged. Died near Big Waterfall at Middle River, but date and burial place not exactly known.

(2) Old Suke. According to an old resident, Robert Snelling, she was the last Tasmanian to die, probably in 1888, as per Destitute Board Minute.

(3) Betty ('Polecat'). Taken to Kangaroo Island with 'Puss' by Robert Warlens in 1817 or 1819. Afterwards known as Betty Thomas, mother of Mrs. Seymour and Mrs. Simpson. Her grandson, Joe Seymour, states she died in 1878 near Stokes Bay.

(4) Puss arrived at the island with Betty, see above. Date of death and place of burial not known.

(5) Little Sal. Buried at Springy Water, Stokes Bay, in 1877. Two old residents regarded her as Tasmanian, but others said she was definitely a native of South Australia. Discovery of her remains may possibly be effected.

6TH JUNE, 1938

A meeting was held in the Society's Room. Dr. W. L. Crowther presided.

Mr. A. L. Butler read a paper on 'The Life and Work of John Gould' in connexion with the centenary of his arrival in Tasmania. The following is an abstract of the paper:—

John Gould was born at Lyme Regis, Dorsetshire, England, on 14th September, 1804. When Gould was 14 his father received an appointment in the Royal Gardens at Windsor. There Gould acquired a knowledge of British birds and studied the technique of avi-taxidermy.

In 1827 he was appointed taxidermist to the newly formed Zoological Society in London, a post which he held for about 11 (or 14) years. In 1829 he married Miss Coxen (died 1841). She painted 600 of his bird pictures, mostly from his rough sketches, and afterwards redrew them on stone. In later years his finished drawings were made by Edward Lear, H. C. Richter, and William Hart.

After his marriage he embarked upon a series of ambitious monographs. Owing to difficulties in finding a publisher he decided to become his own publisher, and in the course of half a century he issued in parts a series of publications which make 41 folio volumes with 2999 hand-coloured plates.

In 1830 he produced the *Century of Himalayan Birds.* This was followed by his monograph on *Toucans* (1834), *Birds of Europe,* 5 vols. (1835-37), *Trogans* (1838). In 1837-38 he published his first Australian work, a *Synopsis of the Birds of Australia,* but he soon found that he had not sufficient material to carry on the work, and he took the heroic resolve of going to Australia with his wife and eldest son, J. H. Gould, and an assistant, John Gilbert. They left England on 16th May, 1838, in the barque 'Parsee,' 348 tons, Capt. John McKellar, which arrived at Hobart Town on 18th Sept., 1838. Gould carried letters of introduction to Sir John Franklin, then Lieut.-Governor of Van Diemen's Land. The Franklins showed Mr. and Mrs. Gould the greatest kindness, and Mrs. Gould and her son stayed at Government House, Hobart Town, for nearly ten months while Gould visited the mainland of Australia. Mrs. Gould was staying at Government House when Franklin Gould, the youngest son, was born.

During his stay in Van Diemen's Land Gould received considerable help from Rev. Thomas James Ewing, R. C. Gunn, and many other local naturalists. This assistance was generously acknowledged by Gould in his published works.

Gould returned to England in 1840, and at once recommenced his *Birds of Australia.* By the efforts of Gould and his assistants the number of Australian species had been increased from 300 to 600. The seventh volume of this work was completed in 1848. The total cost of Gould's expeditions to obtain the birds and the expense of publishing the 600 plates was about £2000.

Mention should also be made of Gould's *Birds of Great Britain* (1862-73) with 367 plates, his *Birds of New Guinea*, with 320 plates, commenced in 1875 and finished in 1888 after his death by Dr. Bowlder Sharpe, the *Birds of Asia* (497 plates) commenced in 1850 and completed in 1883 after his death by Dr. Sharpe.

Mr. Butler concluded with an appreciation of Gould's genius as an ornithologist who had first-hand acquaintance with the Australian birds as the result of arduous expeditions into the bush.

Dr. Lewis gave some notes, abstracts of which are given below:—

1. *Productus subquadratus* Morris

Count P. E. de Strzelecki visited Tasmania 1841-42. His geological explorations in the island resulted in the discovery of a large number of fossils, many of which proved to be new to science. One of these, *Productus subquadratus* Morris, was given the vague locality 'Mt. Wellington to Dromedary' by Strzelecki. It is a rare form which, apparently, was not found by succeeding geologists. The single specimen found by Strzelecki is lodged in the British Museum. Dr. Lewis has now discovered several specimens on the slopes of Mt. Wellington and Mt. Dromedary, and these have been sent to Miss K. I. Prendergast, of Cambridge, for examination and description. The species would appear to be found very sparingly in the upper permian blue limestone which skirts Mt. Wellington, Mt. Faulkner, and Mt. Dromedary, and is found associated with *Aviculopecten*, *Eurydesma*, and *Spirifer*.

2. *Tasmanian Trilobites*

The work of the palaeontologists Dr. Kobayashi, of Japan, and Dr. Whitehouse, of Brisbane, has thrown new light upon the Tasmanian trilobites, and has added to the interest created in this group by the earlier investigators Charles Gould, Stephens, and Robert Etheridge, Junior. Dr. Lewis records his discovery of a new trilobite area at Junee. It is hoped that papers by Drs. Kobayashi and Whitehouse on this interesting group will be published next year in this Journal.

3. *Glaciation in the Florentine Valley*

Included in his paper 'Notes on Pleistocene Glaciation, Mt. Field to Strahan' (*vide* p. 161 in present volume).

4. *Notes on the Geology of the Russell Falls River Valley*

11TH JULY, 1938

A meeting was held in the Society's Room. Dr. A. N. Lewis presided.

Mr. M. Blackburn was elected a member of the Society.

Mr. J. W. Evans submitted the following papers, which were taken as read:—

1. 'Australian Jassoidea. Part 8.' (See p. 1 of the present volume.)
2. 'A contribution to the study of the Jassoidea.' (See p. 19 of the present volume.)

Mr. A. W. Knight, M.E., B.Sc., A.M.I.E. (Aust.), gave an illustrated lecture on 'Bridge Engineering.'

Mr. Knight said there were some indefinite records of small bridges said to be 2000 years old. The Romans were the real bridge builders of antiquity, and beam bridges resting on piles were the type most popular.

The principles of the arch and suspension bridge appeared to have been known to the inhabitants of India, Japan, China, and Europe for at least 2000 years. The Romans brought the masonry arch to its high degree of development. With the fall of the Roman Empire, bridge construction in Europe came to a stop, and no progress was made until the 17th century.

The first cast-iron bridge was built in England in 1776, and the first iron railway bridge in 1823. About 1890 steel came into vogue, and entirely supplanted the use of iron. Reinforced concrete, which was developed in France, was first used about the same time. The development of those materials enabled longer spans to be constructed, and was the fundamental reason for the development of the modern art of bridge construction. The limits of the art were not yet reached, for the era of long span bridges had only just begun. It would be possible to build a bridge of at least twice the span of any yet constructed.

In bridge designing, Mr. Knight said, simplicity was most important, and the easiest way was the best. Principles of true economy must be applied to every detail. Rigidity was as important an element as strength, and the strength of a bridge was the strength of its weakest part.

Bridges in Tasmania at one time were constructed generally of timber. Their life had been about 25 years, but the period was becoming increasingly less because the quality of the timber was inferior. The policy to-day was to build of better materials, and permanent bridges generally were of concrete or steel.

8TH AUGUST, 1938

A meeting was held in the Society's Room. Dr. A. N. Lewis presided.

Provision was made for the admission of Associate Members.

The aims and scope of the Biological Survey of Tasmania were discussed, and three papers were read.

The following is an abstract of a paper by Dr. V. V. Hickman:—

The Tasmanian Biological Survey was established in 1937. The preliminary aim of the survey is the compilation of complete lists of the flora and fauna of the State. The schools, Tasmanian Field Naturalists' Club, and many persons interested in the study of natural history are giving valuable help by collecting specimens in different localities. Such work is a necessary prelude to the investigation of the distribution of animals, the relation between plant and animal communities, the influence of environment on flora and fauna, &c. Such ecological work is not only of the greatest academic interest, but also of economic importance. Plagues of mice, grasshoppers, thrips, aphis, &c., are special cases of a regular phenomenon of periodicity in numbers. A knowledge of the biotic factors responsible for these periodic increases in animal populations can be gained only by a careful biological survey carried out over a number of years. The survey may also provide useful data in regard to the advisability or otherwise of introducing foreign animals and plants into Tasmania, the biological control of pests, and the nature and quantity of trout-food in the lakes and streams at different seasons of the year.

Lantern slides of certain apparatus used in biological survey work were shown.

The following is an abstract of a paper by Mr. J. W. Evans, M.A.:—

A brief account was given of the geological history of Australia since Upper Permian times, and of the principal sources from which the Tasmanian fauna is drawn, special mention being made of the connexions with Antarctica. This

was followed by an account of certain animals, largely invertebrates, which occur in Tasmania and which are of outstanding interest. In conclusion it was stated that much remained to be learnt about the fauna of the island, and that it was certain that many new forms awaited discovery.

The following is an abstract of a paper by Mr. D. Martin, B.Sc.:—

The Botanical aspect of the Biological Survey was divided into four parts:—

1. The necessity for reviewing past work, cataloguing, and, if possible, obtaining copies of literature.
2. The locating of type specimens and overhauling and checking specimens in the local herbaria.
3. The completion of 1 and 2 then shows the gaps in our collections and allows us to judge the importance of any new material.
4. A statement of the present position.

The deficiencies in our knowledge of the vegetation was then approached from three aspects:—

From the point of view of the species individually.
The vegetation as a whole in relation to the rest of Australia and the world.
The interrelation and association of species in the field.

Lantern slides were shown illustrating climax and seral communities on Mt. Wellington.

12TH SEPTEMBER, 1938

A meeting was held in the Society's Room on this date. Dr. W. L. Crowther presided.

Mr. T E. Doe was elected a member of the Society.

Dr. A. N. Lewis read a note concerning R. M. Johnston's 'Geology of Tasmania,' which was published 50 years ago. It was published on 1st September, 1888, and laid on the table of the Society on the 2nd Monday of September, 1888. Although R. M. Johnston was not the first to work at Tasmanian Geology, he may be, nevertheless, given the title of 'Father of Tasmanian Geology.' His book was printed and published by the Government, who also awarded him the sum of £500. In addition to being a first-class Geologist, R. M. Johnston was also a Botanist of repute and he also made valuable contributions to our knowledge of sea fish and other animals.

Mr. J. C. Wyett, B.Sc., gave an illustrated lecture on 'The Biochemistry of Digestion.' He dealt with the various digestive roles played by the different parts of the alimentary canal. The stages of digestion were illustrated by a motion picture film.

10TH OCTOBER, 1938

A meeting was held in the Society's Rooms. His Excellency the Governor presided.

On behalf of the members of the Society, Dr. W. L. Crowther welcomed His Excellency upon his return from a trip to Europe.

Dr. W. Arundel Orchard, O B.E., D.Mus., F.R.C.M., gave a lecture on 'Shakespeare and Music.' The lecture was illustrated by coloured drawings of various contemporary instruments.

In his introductory remarks Dr. Orchard dealt with the music of the 16th century, with particular reference to contemporary composers and to the interest shown in music by Henry VIII and Queen Elizabeth. He emphasised the influence of Shakespeare's Plays and Poems on Musicians from Thomas Morley (16th cent.) to Chausson (20th cent.). Descriptions of contemporary stringed and wind instruments were given, and the lecturer quoted passages from Shakespeare's plays to prove that Shakespeare had a profound knowledge of music and musical instruments. At various intervals during the lecture gramophone records of 16th century music were given.

14TH NOVEMBER, 1938

A meeting was held in the Society's Room, the President, His Excellency the Governor presiding.

Mrs. D. Archer was elected a member of the Society.

The following papers were laid on the table and taken as read:—

C. G. Stephens and R. F. Cane—'The Soils and General Ecology of the North-East Coastal regions of Tasmania' (printed in full in the present volume, p. 201).

Ellen Clark: 'Tasmanian Parastacidae' (printed in full in the present volume, p. 117).

E. O. G. Scott: 'Observations on some Tasmanian Fishes, Part IV.' (printed in full in the present volume, p. 139).

A. N. Lewis: 'Notes on Pleistocene Glaciation, Mt. Field to Strahan' (printed in full in the present volume, p. 161).

The following papers were read:—

W. H. Hudspeth: 'A Portrait of the Rev. John West.'

'A Pioneer Architect—James Blackburn.'

A number of Blackburn's Plans were shown and the Paper was illustrated by lantern slides.

W. E L. H. Crowther: 'Tasmanian Aboriginal Remains found at Dromedary' (printed in full in the present volume, p. 209).

J. Pearson: 'Relations of the Tasmanian Canoe-raft' (printed in full in the present volume, p. 221).

J. Pearson: 'Frescoes in the Empire Hotel, Elizabeth-street, Hobart.' Photographs of these frescoes were taken before the old building was pulled down. It was stated, without confirmation, that these frescoes were painted by Gould the convict artist. The photographs have now been placed on exhibit in the Museum.

Northern Branch

Annual Report, 1938

In the 1938 Session all meetings, other than the Annual Meeting and Public Lecture, were held in the lecture-room at the Queen Victoria Museum and Art Gallery. An appeal was made that books and records relating to the early history of Tasmania be deposited with the Branch for permanent custody.

23rd May, 1938

Annual Report and Public Lecture

Mr. W. R Rolph took the Chair. The following members were elected to the Branch Council for the forthcoming session:—Mr. F. Heyward (Chairman), Hon. Tasman Shields, Messrs. D. V. Allen, J. R. Forward, J. E. Heritage, A. L. Meston, R. S. Padman, W R. Rolph, and E. O. G. Scott. Mr. N. J. B. Plomley was elected Hon. Secretary and Mr. R. S. Padman re-elected Hon. Auditor.

The statement of accounts, showing expenditure of £5 6s. and credit balance of £31 0s. 10d , was adopted.

The annual meeting was followed at 8 p.m. by a public meeting, Mr. W. E. Masters, B.A., LL.B., speaking on ' The Semaphore Telegraph System of Early Van Diemen's Land.'

20th June, 1938

Mr. V. Sydes was to have spoken on ' Modern Radio,' but the meeting had to be cancelled.

25th July, 1938

Mr. W. R Rolph took the Chair. Illustrated lecture: ' Footnotes to Tasmanian History from Epitaphs,' by Mr. F. Heyward.

23rd August, 1938

Mr. F. Smithies presided. Mr. H. J. King showed ' Colour Moving Pictures of Tasmanian Natural History and Scenery.'

20th September, 1938

Mr. F. Smithies took the Chair. Mr. J A. Dumaresq lectured on ' Veterinary Science and some of its Modern Developments.'

Council Meetings

Meetings of Council were held on: 16th February, 18th May, 15th June, 20th July, 14th September, 20th October.

H. H. Pimblett, Government Printer, Tasmania.

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